METALS and ALLOYS

The Engineering Magazine of the Metal Industries

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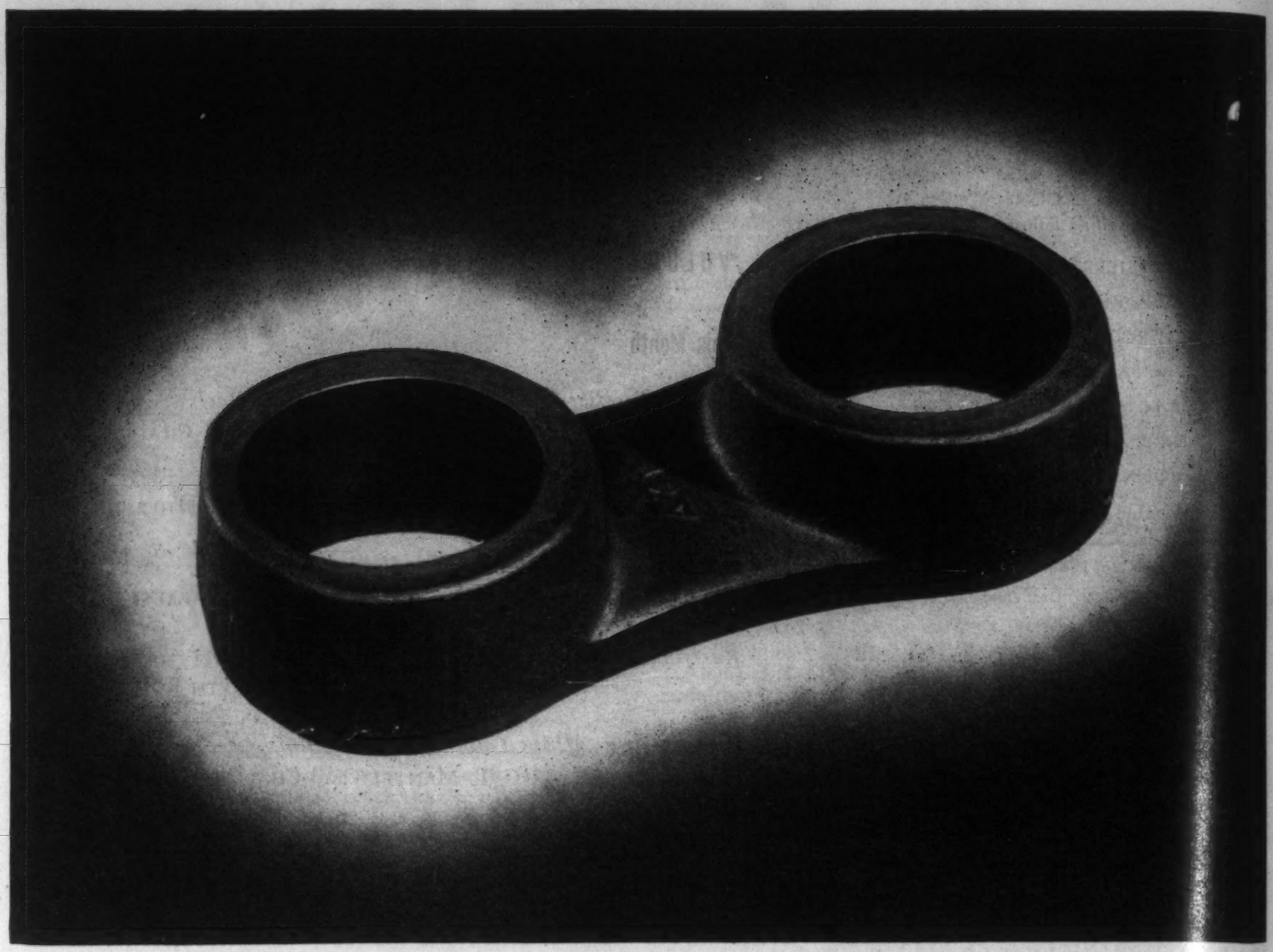

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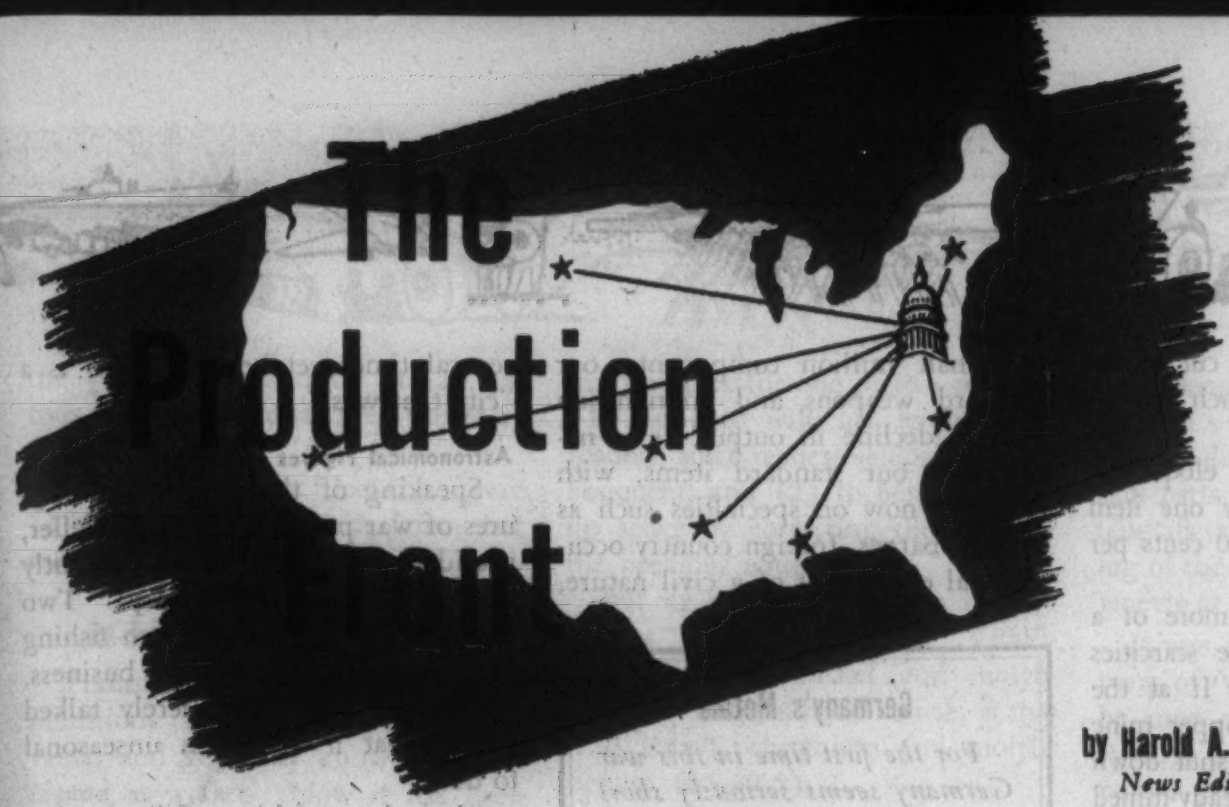


There will not always be a "Production Front". . . . Surplus materials and plant capacity suggest civilian goods output. . . . Yes, but c. g. take labor, transportation, power, etc., and don't leave industry flexible. . . . "Victory" model idea is out. . . . We dip into meagre stock pile for tin.

Copper fairly bursts out of the storehouses. . . . Declining prices reflect plenty. . . . Enough copper for world for four years. . . . Labor "shortage" has been overdrawn. . . . Disabled soldiers will augment labor. . . . Output of standard weapons drops while specialties rise. . . . Here's a new fish story. . . . Thirteen million tons represents: (1) Our 1943 alloy steel output; (2) Japan's total steel capacity.

Many workers must be re-trained for peace. . . . Post-war auto plans more conservative. . . . Will steel landing mats rust? . . . Let's get tin from some sea organism. . . . Consider the high-speed X-ray tube. . . . Aluminum people talk on aluminum.

by Harold A. Knight
News Editor

Twilight Production Zone is Developing

One of these days—we hope soon—the war will be over and we will bid goodbye to the "Production Front." There will no longer be a "front" in the military sense, and we will have to re-title this department. That thought occurs to us because of the present trend to produce more civilian goods with our surplus materials, plant capacity and here and there idle labor.

"Don't think about large scale civilian goods manufacture until the invasion of Western Europe is an assured success," Henry A. Dinegar, director, Durable Goods and Products Div., Office of Civilian Requirements, WPB, told us recently. "Even when Hitler is completely licked, automobiles, refrigerators, etc. will not be produced in unlimited quantities. Look for nothing more than mere easing of civilian restrictions and no outright generosity until Japan is beaten."

"Victory" Models are Doubtful

Neither will we have "Victory" or composite models of typewriters, washing machines, etc. to tide us over during the twilight zone era, Mr. Dinegar told us. Such models would be an entirely new product, and would need a new set of tools, dies, jigs and fixtures.

No, the policy will be to let a few well-established manufacturers produce their last regular models, letting all manufacturers somehow share in distribution and sales. The twilight automobile will not be one stripped of all modern accessories, but rather one of the complete 1941 or 1942 models.

True, by now we have enough raw materials for extensive civilian goods manufacture, but such manufacture would drain manufacturing manpower, absorb electric power, take space in overcrowded transportation, require scarce component parts, and occupy manpower in sales and service that should be devoted to war goods.

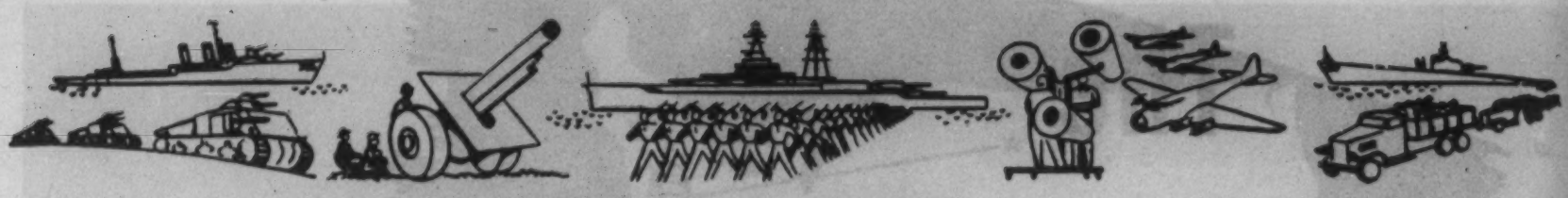
In concluding, Mr. Dinegar (rhymes with vinegar) said: "The Office of Civilian Requirements stands guard against vital shortages on the home front. We do not believe that civilians should suffer just to make them realize that a war is on."

Tin is Chief Supply Worry

As to supplies of metals, there is only one that wrinkles brows with worry. That is tin. We produce in Texas 20,000 tons monthly, import 17,000 tons from Africa. But our consumption is 45,000 tons monthly, meaning that we must dip into our Metals Reserve Corp. stockpile of 100,000 tons to the tune of 8,000 tons monthly.

Copper is a much different story. Here we produce 100,000 tons monthly, import 50,000 tons, having a stockpile of 250,000 tons or more. But we are not quite using up our home production, let alone imports.

Reflecting more abundant supplies, the market price situation comes into the picture for the first time in many months. Definite price reductions have taken place in malleable pig iron, mercury, certain forms of scrap copper, and with market weakness



apparent where no clear cut reductions have taken place, such as concrete reinforcing bars.

Such reductions speak eloquently of ample supplies. Only one item has advanced—coke, by 50 cents per ton in the East.

In fact, surpluses are more of a worry to many than were scarcities on Pearl Harbor Day. "If at the end of the war, every copper mine in the world were to be shut down tight, the supply of already-mined copper would be ample to meet the world's requirements for four years," states the January issue of *Mining and Metallurgy,* quoting an official of a large copper mining company.

Labor "Shortage" Partly a Bugaboo

All along we have maintained that the labor shortage would adjust itself as well as the base materials shortage. We pointed out before that the Steel Corporation has been making higher production records with less and less labor.

Recently, George H. Bucher, president of Westinghouse, summed it up well: "In our opinion, the acute shortage of labor the country over has passed, except in a few isolated cases. As plants become more familiar with the war equipment they are producing, they will find they can turn it out with less labor, which should release men for work that is still expanding."

The number of areas in which there are critical labor shortages continues to drop. More and more disabled veterans are coming back to plants, useful not only as productive units, but as a morale-builder for fellow workers.

Stephen Sheridan, War Manpower Commission representative at New York, tells how plant jobs are being analyzed to see how many human faculties are really needed to operate machines. Many a machine, for instance, takes but one eye and a right hand, say—ideal for a disabled soldier.

Surplus of Standard Weapons

Now as to the production of 2000 major items of war equipment and their half million components, our standard weapons and ammunition tend to decline in output, as is natural for our standard items, with emphasis now on specialties such as landing barges, foreign country occupational equipment of a civil nature, as well as airplanes, heavy trucks, radio and Radar.

Because of the "fluidity of war," as Maj.-Gen. L. H. Campbell, Jr. calls it, the emphasis may change several times yet before Tokyo is a "city that was."

Germany's Metals

For the first time in this war Germany seems seriously short of metals. The decree went out in late January that all of Belgium's church bells must be torn down and contributed as bronze to German ordnance plants. This is the second time in a generation that Belgium's bells have been requisitioned—first for the Kaiser's "Kultur" and now for Hitler's "New Order." Hitler counts on 3000 tons of bronze from them.

Germans are truly missing the metal works products from the Ukraine. North Africa and Sicily disappeared long ago as sources of metallic minerals. Chromite is a more uncertain supply as Turkey leans toward the Allies. Remaining supplies of Russian manganese are small and chances of more seem nil. Sweden is a more reluctant supplier of iron ore, etc. The Nazis are shy of chromium, nickel and molybdenum.

Germany's metal supply can be learned in large measure from captured equipment. Even in the early part of the war, when metals were more plentiful, welding was inferior, beads breaking away from parent metal. The new German tanks are not equal to earlier models, partly because of inferior steel, and partly due to poor welding.

Astronomical Figures and Fishes

Speaking of the astronomical figures of war production, K. T. Keller, president of Chrysler Corp., recently told us the following story: Two big businessmen, with whom fishing is more of a fetish than is business, met in February and merely talked about what it was then unseasonal to do.

"Jack, I was fishing off Boston last September and caught a cod weighing 268 lbs.—they told me it was the biggest cod ever caught."

"Well, Bill," said the other, as he puckered up his lips preparatory to a tall one, "I was fishing off Barnegate in August. Something hit my bait. I struggled for two hours, only to reel in a huge marine light, still burning."

"Say, Jack," put in Bill with a bargaining tone, "I'll knock 250 lbs. off my fish if you'll blow out your light."

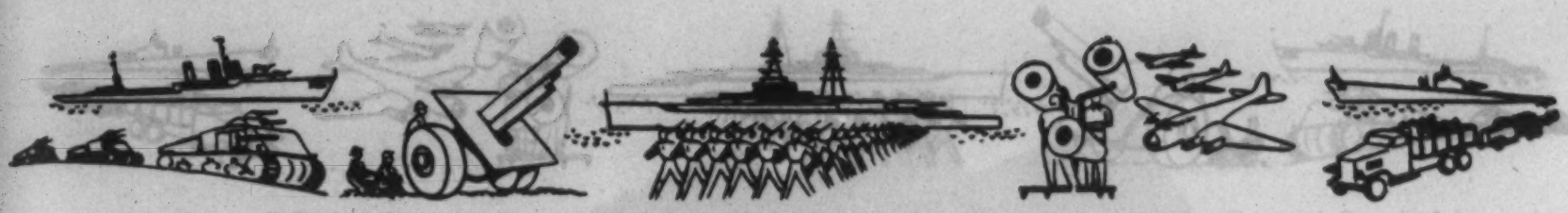
Even our British allies can smile in wartime. We hate to inflict a pun, yet mirroring life as we find it is our mission. A London news photo showed women war workers in bathing suits, basking before sun lamps between shifts. The caption: "Here absenteeism is cut to its barest minimum."

The Unlucky Number

Within 24 hr. a significant figure from two unrelated sources has struck our consciousness. The figure is 13,000,000. It stands for Japan's present total steel-making capacity, and for alloy steel production in the United States for 1943.

That figure for Japan's capacity is the estimate of Charles M. Parker, American Iron & Steel Institute, in his book, "Steel in Action." At Pearl Harbor it was understood that Japan's capacity was 8,000,000 tons. More recently we ran across an estimate of 16,000,000 tons, but we took little stock in it because of supplementary statements that did not make sense to us.

Our exact alloy steel output was 13,116,000 tons, a 14% rise from



the preceding record of 11,526,000 tons in 1942, according to the Steel Institute.

We are confident that the figure 13 will prove unlucky for Japan, but lucky for us.

Re-Training Workers for Peace

Training peace-time workers for munitions making was quite universal and generally known and accepted as a fact. Now it has been suggested that in several industries there will be required a post-war retraining program, so that workmen can relearn certain techniques acquired and maintained only through constant application.

Among these can be included such processes as porcelain enameling, plating and synthetic finishes along with such allied occupations as polishing, buffing and spraying, states H. W. Arlin, manager of the Industrial Relations Dept., Mansfield, Ohio plant of Westinghouse.

Such operations as the proper mixing of enamels, preparation and cleansing of materials, proper application or spraying of enamel, rimming and wiping, proper burning, care and handling of parts—all must be relearned by employees formerly engaged in this work.

Again, there are tool and die makers, but apprentice training has practically stopped because of the demand for young men for the armed services. Industry has been forced to depend largely upon single purpose training instead of the training of all-around machinists. But it is the latter who are needed for the building of tools and dies.

To get back to the enamelers and platers, the violin maestro must always keep his touch by constantly fingering his strings. Even the piccolo player must retain his lip pucker, or embouchure, as our friend Tom Lippert, he of the verbose verbosity, would say it. There is nothing novel in the situation.

"Errata" Less Harsh than "Mistake"

We have heard where certain editors were accused of purposely making mistakes for one or two reasons: (1) So they will get letters from readers, since readers seldom pass out bouquets; and (2) to help them fill up space by correcting the error of the previous issue.

But in our case it was a case of "errata" when we said that "Vitallium" is chiefly nickel and molybdenum. The truth, of course, is that it is cobalt, chromium and molybdenum (65-30-5).

Bo Peep 194?

by V. M. McConnell

[*News items: Willys-Overland Motors, Inc. has perfected plans for 36 civilian post-war uses for the jeep. Among them are farm vehicles for plowing, harrowing, cultivating, stump removal, herding, carrying, towing and power unit; mosquito and insect control, spraying, etc.*]

Little Bo Peep,
Who lost her sheep
When she fell asleep
In the clover,
Will ride a jeep
To attend her sheep
When the dog-gone
War is over.

That Post-War Auto Again

Savings in weight over previously used materials, reductions in cost despite the higher cost per pound of the materials (achieved by reducing fabricating costs), a passenger car body molded with canvas plies, engineered plywood panels of astounding strength, vast improvements in ignition harness insulation, and greater dielectric strengths of ignition parts were among the topics of talk-talk at the recent annual meeting of the Society of Automotive Engineers at Detroit.

It was predicted that within three years of V-day aluminum parts will be used widely in the automobile. A large supply of secondary aluminum at 5 cents per lb. will put aluminum alloy castings in the same price brackets as iron castings. At least 500 lb. of aluminum will be placed in each of 3,000,000 vehicles yearly.

The prophets were less hopeful of magnesium in various forms because of high cost. As for the present, the sprayed metal process holds most promise for brake drum reclamation. For light and medium duty, reclaimed drums are practically as satisfactory as replacements. Worn or damaged engine valves are taken out of scrap bins, cleaned in an electrolytic bath, examined microscopically for flaws, whereupon damaged metal is ground away and new sections welded in.

Some synthetic rubbers are superior to natural rubber for engine mountings and bushings, axle bumpers, fan belts and radiator and brake hose.

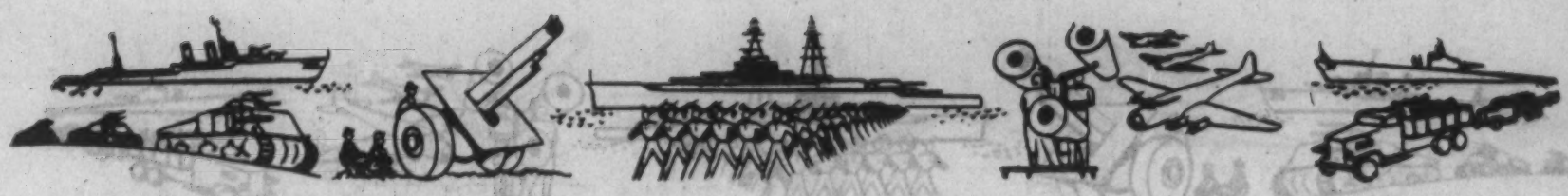
As to fuels, gasoline octane numbers will not climb much above 90 (ASTM) level by 1960. Forced output of higher octane fuels, necessary during war, would be willful waste of 9,000,000 bbl. of crude oil yearly.

In the future, we must measure transportation miles per barrel of crude instead of per gasoline, as during more halcyon days of the past.

But Will Steel Landing Mats Rust?

Steel landing mats for airfield runways are called "one of the most outstanding developments of the war" by Gen. Henry H. Arnold, Air Forces commander. About 175,000,000 sq. ft. of steel mats have been sent to combat theaters and 300,000,000 sq. ft. more are on order for 1944.

We asked Walter E. Irving, presi-



dent of Irving Subway Grating Co., Inc., Long Island City, whether all this talk of post-war uses for driveways, private air fields, etc. is the real McCoy. Aren't such mats subject to extreme corrosion? we asked. He replied:

"The first open mesh steel floor in the world was that on the University Bridge in Seattle in 1932, and opened to traffic in April, 1933. It had not yet been repainted on its tenth anniversary, writes City Engineer Charles Wartelle.

"Permanent runways on the ground is a different proposition. We have never thought of them except as filled with a rust-protecting mastic. You may have heard of our test roadway in Darien, Conn., similarly filled; and we had one here for over 14 years. This was taken off the ground two years ago, when the city wanted to pave the street. Knocking out the mastic (just good sand and road oil), we found everything as bright as the day it was filled."

Metals from Sea Organisms

An expert vegetable gardener in our home town can tell when his soil is acid by the types of weeds that flourish there. Thus, sorrel grows in best profusion in acidity. By the same reasoning, prospectors often locate valuable metals, such as copper and gold, by the type of vegetation growing on the top soil.

"Biological Mining" is an interesting topic in the *Industrial Bulletin* of Arthur D. Little, Inc. for October. Large deposits of manganese on ocean floors may be the remains of animal organisms that had manganese instead of iron in their tissues.

Skeletons of many diatoms are finely divided pure silica. Oyster shells are pure calcium carbonate. Vanadium is concentrated in some organisms with Latin names. The blue blood of lobsters is due to copper instead of iron. Arsenic is found in several crustaceans. Selenium is inherent in one animal.

The metallurgist of the future, in concocting an alloy, may take 67 radiolarians, add 6 ascidians and 4 holothurians, and throw into the electric furnace. Before pouring, 1½ astragalus pectinata will be tossed in for purification, the resulting metal being equivalent to N.E. steels.

But we have been digressing capriciously. To return to the Little bulletin, it concludes: "Millions may be awaiting the biologist who develops a seaweed, which likewise uses gold in its tissues. A sea organism that concentrates tin would be of more intrinsic value today. There is a species of yellow violet that grows only where it can get tin."

More Costly Than the World War

What is it that costs more to run than the whole World War, uses more power than the city of St. Louis, and has a life of only five ten-thousandths of a second? The answer to this $64 question is: a high speed X-ray tube produced by Westinghouse.

Far from being a useless and extravagant laboratory curiosity, it is a practical tool used in industry. The secret, of course, is in the extremely short time during which the tube operates for any one picture or series of pictures.

The time is usually from one-tenth to one micro-second (a millionth of a sec.), but may be extended to 20 micro-seconds for "slow" subjects.

While many of the applications are shrouded in wartime mystery, it may be revealed that the apparatus is being used to study the progress of projectiles in the bore of a gun, and in penetrating armor plate. It also offers possibilities for the study of moving machinery, examination of spotwelding, and in many other fields.

Uses of the apparatus were illustrated at the January meeting of the Metropolitan New York Section, American Industrial Radium and X-Ray Society. Dr. Charles M. Slack, associate research director of Westinghouse Lamp Division, J. M. Constable, of Westinghouse X-Ray Division, and Edward Thilo, of Frankford Arsenal, Philadelphia, were the speakers.

Aluminum People Talk on Aluminum

Although our high grade aluminum ores would last only two or three years if used exclusively at the present rate, America will not have to face an immediate shortage of this raw material. C. C. Carr, director of public relations for Aluminum Company of America, gave some comforting figures at the Aluminum Research Laboratories' Twenty-fifth Anniversary celebration at New Kensington, Pa.

A lime-soda sinter process, now in operation, can be used to work the lower grade ores found in abundance in Arkansas, or to rework material from which a high percentage of the metal content has already been removed.

The Bayer process, as now used, extracts about 70% of the aluminum from high-grade ores, leaving about 30% to be obtained by some other means. Mr. Carr stated that his company was now recovering about 70% of this remainder, giving a total yield of over 90%.

Pointing out that 75% of the weight of most airplanes is aluminum, Mr. Carr expressed his belief in the future of the metal. Several other products have already been produced in aluminum, in preparation for the post-war markets. The industry, which ten years ago gave employment, directly and indirectly, to 200,000 workers, now employs 200,000 directly, and probably two or three millions indirectly.

Three factors in the picture for post-war aluminum are lower price—the price has been reduced during the war; more workmen are familiar with the working of the metal; and several sources of supply are now available to the purchaser.

Dr. Francis C. Frary, director of research for the company, in receiving the Twenty-five Year Award from Roy A. Hunt, the company's president, outlined the studies made of suggested processes for preparing aluminum, and for making it cheaper, stronger and more usable. Much of this work, done years ago, had made possible the wartime aircraft program.

"Reversion" of War Plants

There are considerable speculation and varying opinions as to the disposition of many of the plants now working on war contracts and turning out fabulous quantities of war material. In the early stages of the war the conversion of many plants, such as the automobile and others, was a problem. Many of them were converted over-night, so to speak. The story of this overnight conversion has certainly been one of the most stirring chapters in American industrial history.

There is, however, another and perhaps an even greater story yet to be written—the "reversion" of the plants to peacetime products. In this case much will depend on the industry involved. Reversion problems in the metal industries will vary widely. Aluminum and magnesium will contrast strongly with some of the other metals. But the importance of rapid reversion, or re-conversion, will be as insistent as in the case of conversion for defense and war. The scarcity of many civilian products formerly made will result in a very large demand for them and the problem of employment for those returning from the war and from war plants will be another incentive for quick conversion back to peace time.

There is every reason to believe that the reversion at the end of the war will be just as rapid in most cases as was the conversion in the early stages of the war. American industry accomplished a monumental task in conversion—it will be equal to the reversion job after the war. —E.F.C.

Super-Duper Mass Production

Throughout the machine age, which is contained in the past century, there have been periodic fears lest machinery do away with the need for labor and cause drastic unemployment. However, mass production has never proved the bugaboo which it had often been painted. Somehow machinery begot more machinery and also more employment. The automobile industry has been a good example of how mass production has created jobs for millions. It gave birth to many auxiliary jobs, such as making road building machinery. It pyramided employment and its beneficial influence spread throughout all industry.

Yet one wonders if at last machinery is not about to catch up with all the dire predictions made these many years. Will it not at last prove the Frankenstein monster that destroys its creator?

During the past two years mass production has become super-duper. Nine out of ten win-the-war ideas in industrial plants have promoted faster production. Multiple operations have supplanted single strokes. Side line operations have been incorporated in the main production line. Thousands of operations have been speeded up 50 to 500 per cent. Cash awards and medals have gone to the workman whose ideas led to greater output. It goes without saying that practically all war techniques will carry over to peace.

With 10,000,000 fighting men coming back to civilian life and with our accelerated production techniques, how on earth can we consume all the products of the plants? Will plants be able to work more than three months out of each year?

Finer Things
Are Coming Out of the Ground

From the ore ranges, the coal fields, and the limestone beds are coming vast quantities of blended iron ore, coking coal, and purest limestone—the principal ingredients for making steel, the "master metal" in both peace and war.

Today this steel must all go into the production of the materiel of war, but tomorrow, when Victory is ours, finer things will come to us from out of the ground because of improvements now being made in steel.

Inland metallurgists are constantly testing and re-testing, melting and re-melting, adding one element and taking away another—always seeking for something better. Already they have contributed many new methods and new steels to production for war.

These, and the newer methods and Inland steels that are sure to come from continued intensive research, will help you meet the needs of America at peace.

INLAND STEEL COMPANY

38 South Dearborn Street, Chicago 3, Illinois

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Of course at first there will be a starved public to satisfy. Again, a large share of the so-called civilized world has been demolished by war and will have to be built up.

Yes, but what then? In our imagination we see two somewhat new and novel possibilities of additional consumption. The first is a consumption outside of the United States. Our soldiers have been all over the world, in one sense as missionaries. Natives who have helped unload our jeeps in the South Pacific have secured a broader horizon and may want the modern utilities. If we restore Manchuria, Korea, etc. to China, we will have a hand in modernizing them. All backward countries may in part be elevated to a more average level.

Now as to home consumption, the progressive industrial plant is quick to scrap the only slightly obsolete equipment and put in more modern equipment. Why can't the average consumer work on the same principle? Won't our own standard of living have risen in the same accelerated pace as our war industry? Won't we discard the old refrigerators, heating plants, vacuum cleaners, etc. and buy the new streamlined post-war equipment? —H. A. K.

The Engineer in the Community

Technically trained men can make valuable contributions to the civic affairs of their own communities, especially in such problems as require their special knowledge for solution. The thought that technical men should not confine their activities to purely professional employment was the central theme of an address by Dr. Du Bois accepting the Perkin medal for outstanding achievement in chemistry.

Taking as his subject "The Chemist Steps out of the Laboratory," Dr. Gaston F. Du Bois, senior vice president of Monsanto Chemical Co., called for a more active participation in governmental affairs by engineers and other technicians. "Men trained as engineers have played too little part in the affairs of government," he said, and urged that they had not only the right, but an obligation to assume their share in the duties of government. There are many civic problems to the solution of which the special knowledge of the engineer can contribute, and the government would be responsive to suggestions from such groups. He mentioned such things as smoke abatement, to which he had made important efforts in his home city, St. Louis.

It seems obvious that in a society whose achievements are very largely based upon technical progress the men with special technical skills can make a special contribution to civic affairs. There is no reason why the engineer should not hold as distinguished a position in the community life and its social scale as the physician, lawyer, or other professional man, and it is gratifying to see this attitude becoming more general. —K. R.

How to be a Great Technical Society

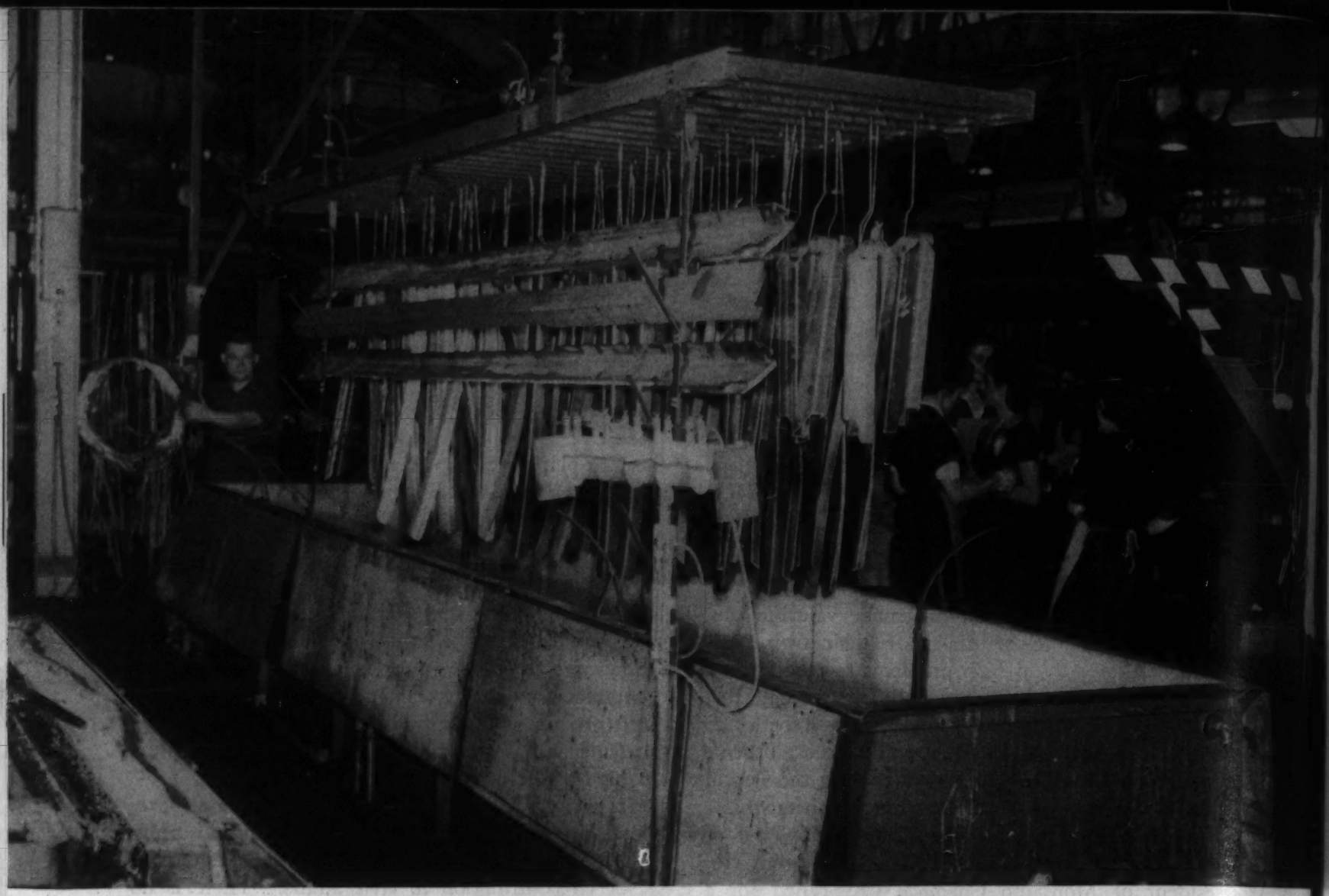
A truly unique honor has been recently conferred by the Ordnance Department on the Society of Automotive Engineers—the presentation to the Society of the Department's Distinguished Service Award "in recognition of outstanding and meritorious engineering advisory services in war and peace; in design, manufacture and maintenance of ordnance matériel."

This award is the first of its kind ever presented to any engineering society and is richly deserved. It is the best justification, if any were needed, of adherence by a technical society to a policy and program that put service to the Nation and to its professional field far ahead of self-aggrandizement, promotion and the enlargement of its treasury beyond necessity. It is on-the-record proof that a society's headquarters staff can better serve the ends of Victory by quietly and efficiently devoting its energies to the solution of specific and vital technical problems through committee action on a mass scale than by any other means.

A technical society can do many things in its zeal for growth and influence that may in time nullify its actual contributions and ruin its prestige. S.A.E. has carefully avoided these practices and pitfalls. It does not, for example, seek new members just to add to the Society's size, and is interested in intensively developing only its own clearly-defined field; it does not eye what may appear to be greener pastures close by as possible additions to its scope.

As an editor of an engineering magazine we naturally are sensitive to the publishing policies of other technical journals. For *S.A.E. Journal* we have nothing but the highest praise. In using the limited paper supply made available to it, the Society has considered the maintenance of its editorial services to its members of greater importance than the unrestrained expansion of advertising volume in its magazine.

In short the S.A.E. in all its projects has put engineering service above profit. The receipt of the Ordnance Department's unique award demonstrates that this policy contains the elements of greatness and is recognized as such. It is, indeed, a policy that could well be emulated by those few technical societies who may now be moving in a somewha different direction. —F.P.P



A rack loaded with both long and short parts being lowered into the degreaser tank by the crane operator at the far end. The arc shaped strips at the tank edges help to guide the rack as it is lowered. When in place, the doors are closed.

Rapid Anodizing and Painting of Aircraft Parts

by HERBERT CHASE

The practice and equipment for speeding-up the finishing of aircraft parts described in this article include some interesting innovations, especially the extent of mechanization. —*The Editors*

RAPID AND EFFECTIVE anodizing and subsequent spray painting of aluminum parts for Avenger planes is accomplished by a simple but well-mechanized set-up in the plant of Eastern Aircraft, Trenton Division, General Motors Corp., Trenton, N. J. The parts treated range in size from several feet over-all to a few inches in maximum dimensions. Those of the smaller sizes are received by the anodizing department largely via overhead monorail carriers and the larger parts on lift trucks. After being checked in and inspected, the parts are ready for racking.

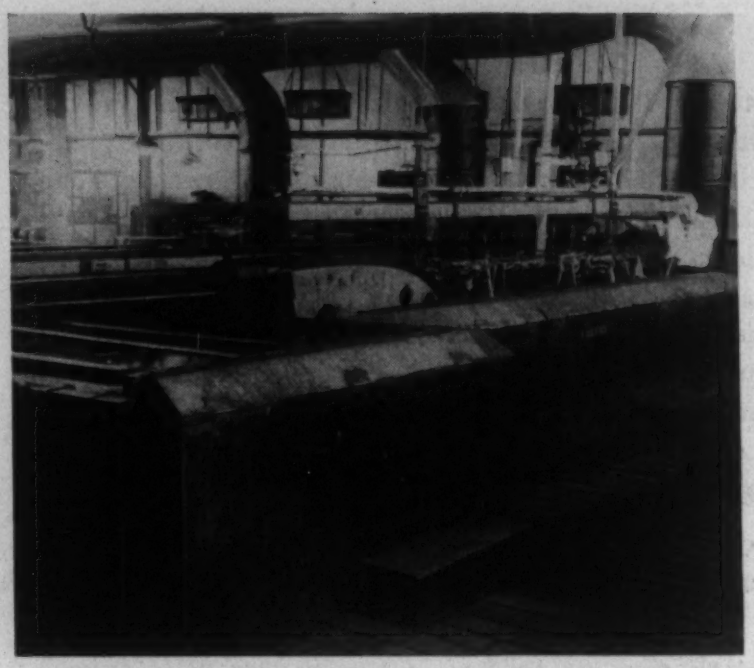
Handling Equipment

It is necessary, of course, to employ aluminum supports, chiefly of the coiled spring type, and these are subjected to anodizing along with the parts. As the anodic coating is a non-conductor, it is necessary to strip the supports used in previous batches before they can be applied again. This is done by dipping them in a solution containing 4 to 6 oz. per gal. of trisodiumphosphate heated to a temperature of 160 to 180 deg. F. until good gassing results, the time averaging about 15 sec. Stripping is followed by rinsing in hot water. This treatment does not leave the supports bright but the anodized coating is removed and a good electrical contact with the parts subsequently held results, chemical attack on the support being slight.

Girls do the stripping and the subsequent racking, the latter on benches equipped with central wooden rails which hold a supply of the aluminum spring racks where they are easily reached. It is a simple matter to spread the spring coils enough to receive and grip the parts. The opposite end of the wire forming the support is hooked for hanging on large master aluminum racks which carry the parts through cleaning, anodizing, rinsing, and a subsequent drying operation. Master racks are some 12 ft. in length. Longitudinals are aluminum channels and between these are transverse bars at about 6-in. intervals forming a grid from which the work is hung. An average load has about 600 sq. ft. of surface to be anodized. Parts too long (over 65 in.) for hanging from one end are placed horizontally and have two supports. All spring racks must make good electrical contact both with the parts and with the master overhead rack.

While loading, the master racks rest on a support at each end and about 7 ft. above the floor so that girls who do the loading can walk underneath and still reach the transverse bars. After the master racks are loaded they are handled by a 1000-lb. overhead crane controlled from the floor. This crane has a carrier which supports the rack from four hooks attached near each corner.

After shifting over the degreaser tank, the cover of the latter is raised and the load lowered into the trichlorethylene vapor where the parts remain for 3 to 5 min. during which they attain vapor temperature. If the parts are unusually greasy, they are sprayed with liquid solvent from a nozzle served by a pump. Otherwise, vapor cleaning is inadequate. This cleaning makes the parts ready for anodizing and the loaded rack is shifted into the anodizing tank.



A load of degreased parts entering the anodizing tank. The tapered blocks on the under side of the rack channels make electric contact with sockets joined to bus bars.

Anodizing

On the under face of each longitudinal of the master rack are three tapered contact blocks which come to rest in sockets connected to the copper bus bars. When in position, the voltage is raised in about 10 min. to 40 volts and then is held constant for 30 min. as anodizing proceeds. This potential results in a current of 1½ to 3 amp. per sq. ft.

Operators loading the anodizing rack as it is supported overhead. The rack as well as the supports are of aluminum.

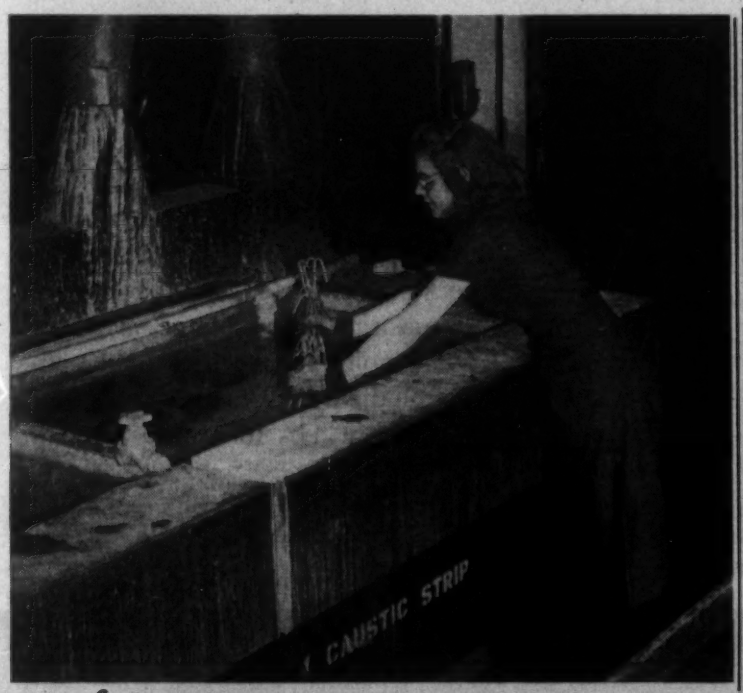
A standard chromic acid bath is employed in the 4000-gal. tank which is glass lined, but has a vitreous brick bottom. The solution is constantly circulated by pumps at the rate of 3500 gal. an hour through one of a pair of external heat exchangers, flowing in at the top and out at the bottom of the tank. By this means, the temperature is held at 95 deg. F., plus or minus 4 deg., by action of automatic thermostatic valves. Steam is used for heating and tap water for cooling in the exchangers. Cooling is required because the current flow would otherwise overheat the bath.

Spray-Painting

Upon completion of anodizing the loaded rack is shifted to a tank in which the parts are rinsed by water at 160 to 180 deg. F. for 2 to 3 min. The next shift is into a dry tank having at each end a steam-fed unit heater from which hot air is discharged to dry the load. When dry, the load, still on the rack, is shifted onto fixed supports for unracking the anodized parts, an operation performed by women. The parts are laid on benches and, after inspection for cracks, they are ready for spraying.

Stripping (upper left) of the anodized coating from the coiled wire supports is done by a 15-sec. dip in the trisodiumphosphate solution in these tanks. Unloading parts (upper right) which have been anodized, rinsed and dried and are ready, after inspection, for spraying with the primer.

After they are sprayed, a woven wire belt (below) carries the parts under a bank of infra-red lamps for drying the primer. The return belt, stripped of paint, is seen at the lower level.



Spraying zinc chromate primer on anodized parts as they are advanced on a woven wire belt. A water curtain catches the excess spray.

This spraying is done by women using zinc-chromate primer as the parts are advanced through spray booths on woven wire belt conveyors. Anodized parts are laid on the belt as they pass inspection. After spraying one side, the parts pass under a bank of infra-red lamps which dry the primer. The parts are turned over before they enter the next spray booth. Each booth has a water curtain to catch excess spray. After passing through the second spray booth and under a second heater bank of lamps, the parts are unloaded for delivery to assembly departments or stock rooms.

Since the woven wire belt receives some of the spray, it is passed through a stripping tank as the unloaded side returns at low level. The stripping solution contains 6 oz. per gal. of caustic soda.

Virtually the entire operation is handled by women. As the parts are aluminum, they are light and almost the only manual handling is in loading and unloading conveyors and racks which are power actuated. Solutions are handled and their temperature controlled automatically. Electrical control of the anodizing is also automatic, requiring only occasional supervision by technical personnel.

Hardenability of 4150 Steel

— Effect of Segregation

By H. L. WALKER, E. J. ECKEL, J. HINO and F. H. MUELLER

Professor, Instructor and Graduate Asst. in Metallurgical Engineering, respectively, University of Illinois, Urbana, Ill., and Director of Research and Development, Mueller Co., Decatur, Ill.

For the manufacture of certain munitions (whose nature we are not permitted to disclose) it is essential to use SAE 4150 steel and to know its hardenability. The authors point out that the hardenability at the center of 4150 bar stock may be different than that at the surface, demonstrate that this anomalous center behavior is due to segregation and suggests heat-treating and testing practices to minimize its effects.
—The Editors

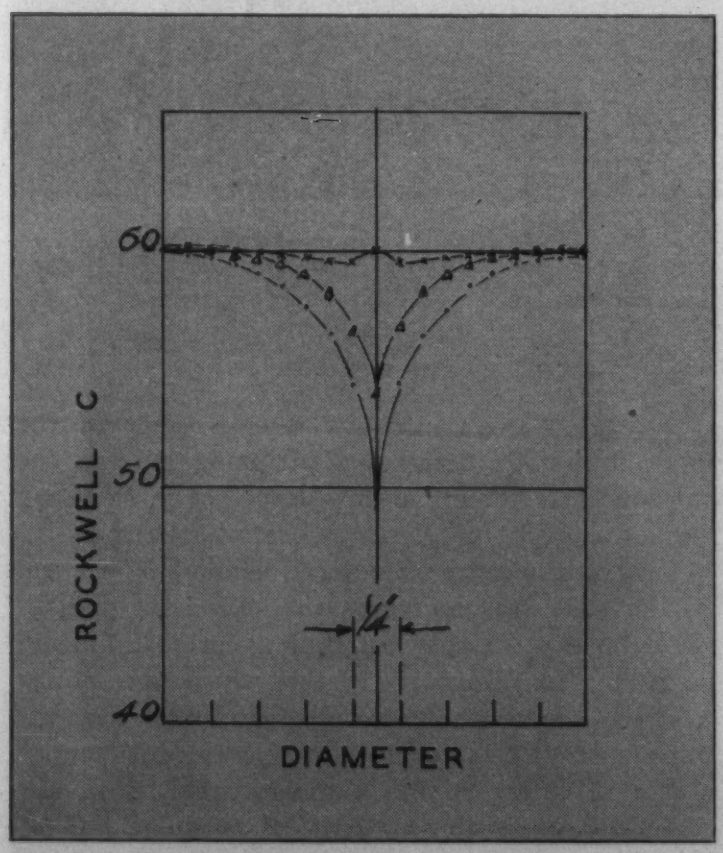
IN THE MANUFACTURE of cylindrical articles, with a diameter of approximately 2.25 in., from S.A.E. 4150 steel, it was found desirable to have a center hardness of Rockwell C 54 to 55 to meet the service conditions imposed upon the steel. The heat treatment was based upon Jominy hardenability specimens which had been prepared by machining the 2⅜-in. bar stock down to the 1-in. Jominy specimen size.

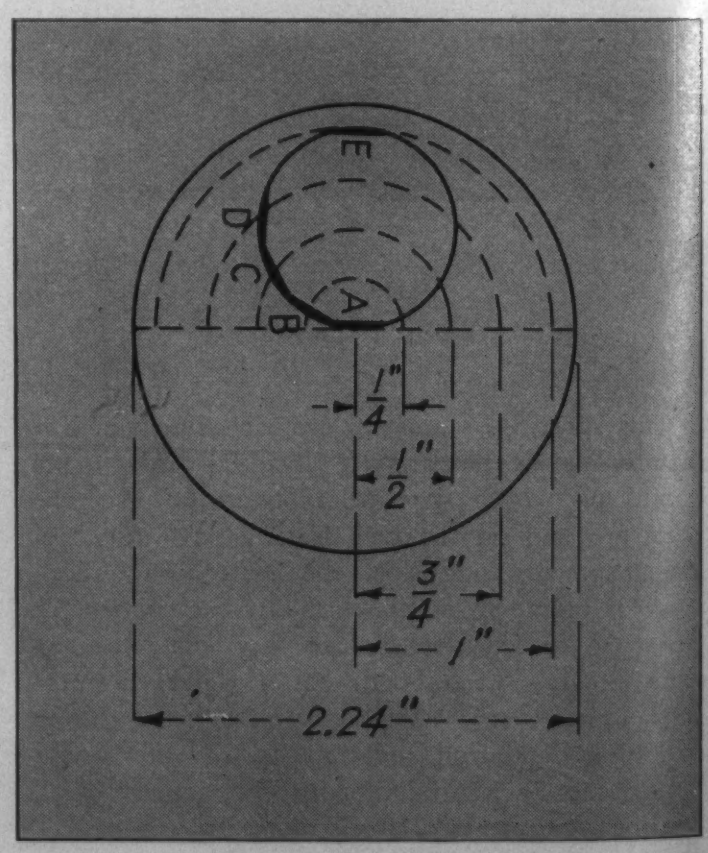
The results of the heat treatment of different heats of steel from the same manufacturer or from different manufacturers did not always correlate well with the results of the Jominy hardenability test. Some heats would attain a hardness at the center as predicted, while other heats would show considerable variations in individual hardness readings toward the center, and still other heats exhibited a low hardness toward the center with hardness values as low as Rc 48. These variations in cross sectional hardness values are illustrated in Fig. 1.

The Heat-Treating Problem

The carbides in 4150 steels are known to dissolve slowly, and in many instances considerable lengths of time are required at maximum temperature for good carbide solubility. The problem in heat treat-

Fig. 1. Variation in cross-sectional hardness of different heats of quenched 4150 steel, 2.24-in. rounds.
Fig. 2. Location of Jominy bar for determining the hardenability at various intervals along the radius of bar stock: (A) Center of bar, (B) 1/4 in. from center, (C) 1/2 in. from center, (D) 3/4 in. from center, and (E) 1 in. from center. The Jominy bar is ground 0.015 in. below surface at points A, B, C, D, and E.





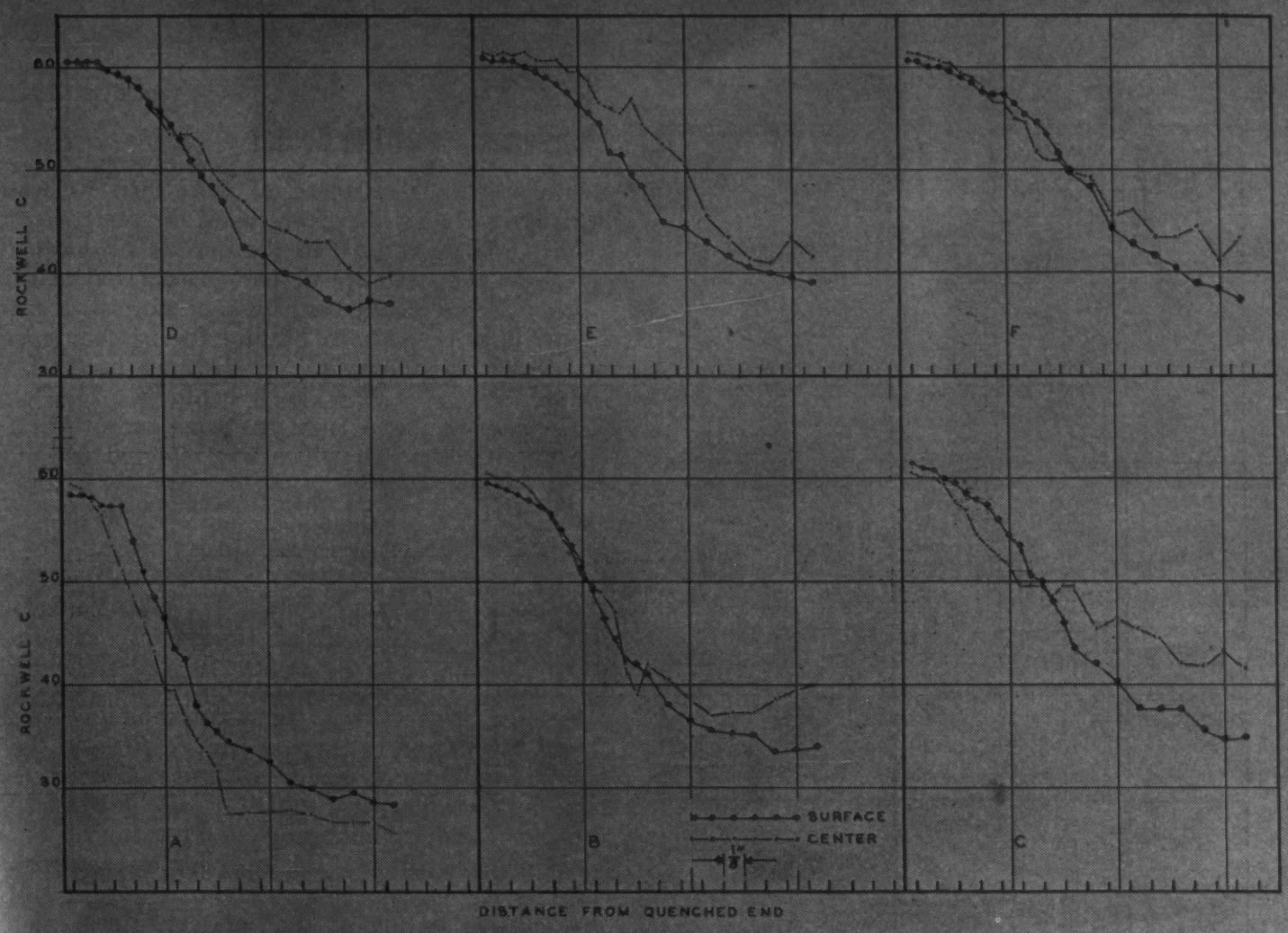
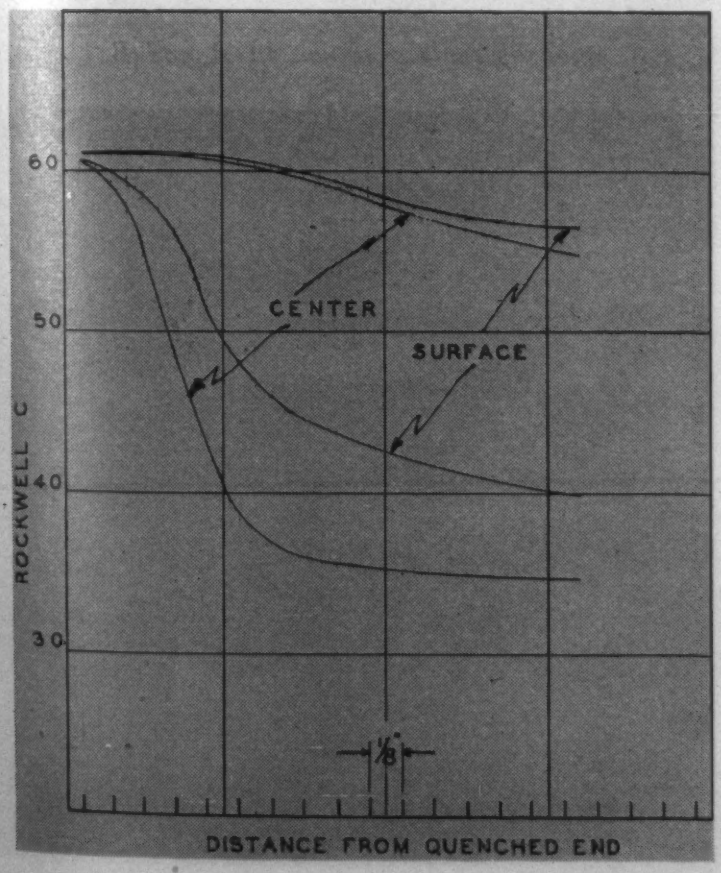


Fig. 4. Effect of temperature and pre-conditioning treatment upon the hardenability at the center and surface of bar stock: A. Heated 7 min. in lead bath at 1500 deg. F. B. Heated 7 min. in lead bath at 1550 deg. F. C. Heated 7 min. in lead bath at 1600 deg. F. D. Heated 7 min. in lead bath at 1650 deg. F., air cooled, reheated 7 min. in lead at 1500 deg. F. E. Heated 7 min. in lead bath at 1650 deg. F., air cooled, reheated 7 min. in lead at 1550 deg. F. F. Heated 7 min. in lead bath at 1650 deg. F., air cooled, reheated 7 min. at 1600 deg. F.



ing was aggravated because a comparatively short heating cycle in a lead bath was being used; however, a substantial increase in the time of heating at temperature did not seem to correct the variations in center hardness. An increase in temperature from 1550 to 1615 deg. F. without an increase in time was usually sufficient to bring the center hardness up to desired values, but this temperature was too high for quenching and resulted in cracking troubles, and the erratic hardness numbers found in the center areas were not eliminated.

Microscopic investigation indicated that some of the heats showed considerable segregation toward the center of the bar stock. The most serious disadvantage of the Jominy hardenability test is that it fails to show the effects of segregation. For bar stock of the size being used it is an easy matter to machine Jominy bars and determine the hardenability at various points along the radius. The Jominy hardenability at the center and surface of the bars is now regularly determined and used for production control.

Fig. 3. Illustrating extremes in Jominy hardenability of different heats of modified 4150 steel. Bars were heated in lead bath for 7 min. at 1550 deg. F.

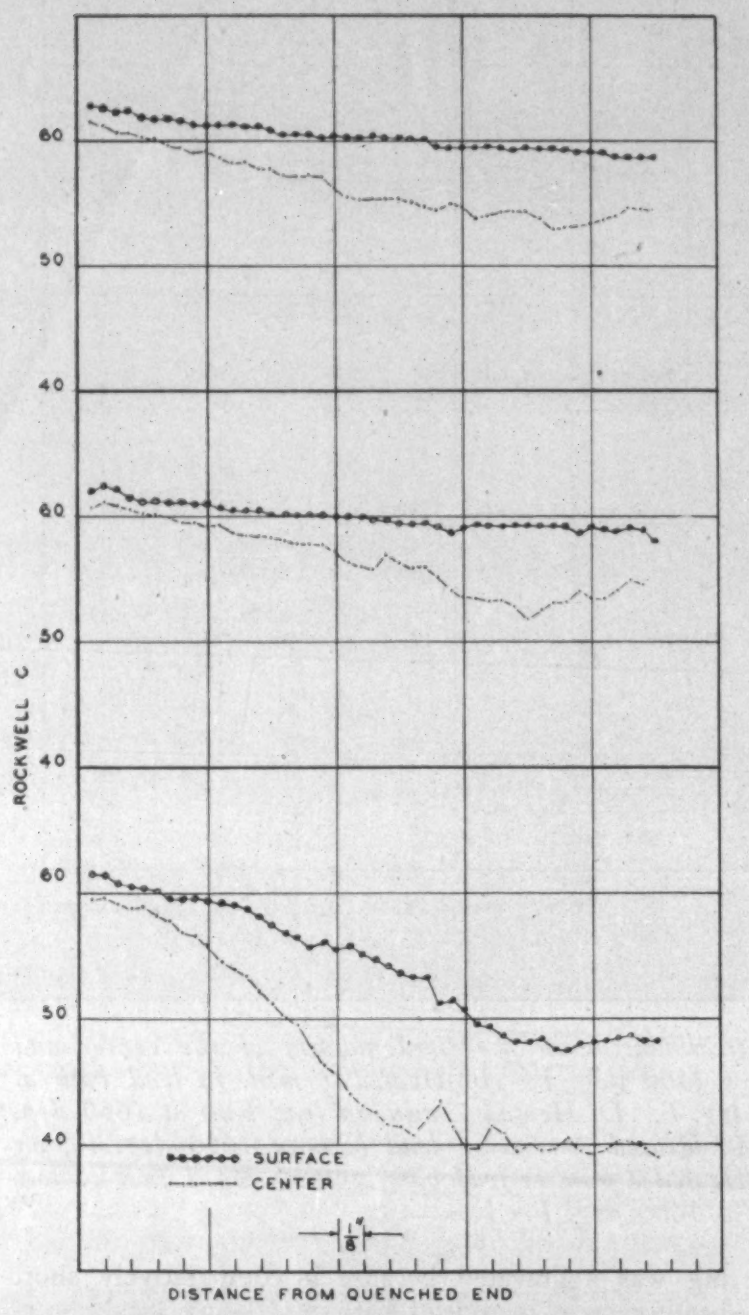


Fig. 5. Jominy hardenability of center and surface area of three heats of steel showing low center hardenability.

Since the diameter of the bars is greater than 2 in. it is very easy and convenient to machine a Jominy bar from the radius of the bar stock. The location of the test specimen is illustrated in Fig. 2. One side of the Jominy bar is machined so that it intersects the center of the bar stock. The chords at A, B, C, D, and E on the Jominy bar (Fig. 2) indicate the locations where hardness values are read after the surface has been ground to a depth of 0.015 in.

Fig. 3 shows some extremes in Jominy hardenabilities for different heats of steel, when the Jominy bars are processed with a time-temperature cycle approximating the cycle used in regular heat treatment. These variations in the hardenability of different heats of steels have required considerable flexibility in heat-treating equipment and adjusting of heat-treating cycles.

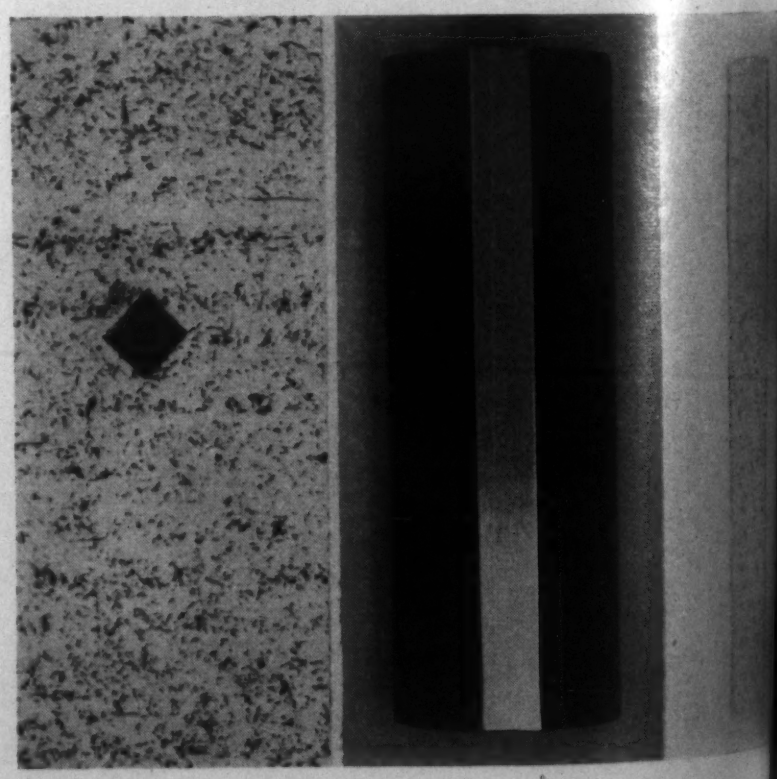
Hardenability at the Center

In only four instances, of more than 50 heats of this type of steel, have we found the center hardness equal to or greater than the outside hardness. Fig. 4 shows the influence of temperature and of a conditioning treatment, consisting of normalizing from 1650 deg. F. prior to heating for hardening, upon the hardenability of one of the four heats of steel which develop a high center hardness. The Jominy bars were prepared from the same bar of steel, the chemical analysis of which was reported as follows:

Carbon	0.56
Manganese	0.79
Phosphorus	0.017
Sulphur	0.030
Silicon	0.33
Chromium	0.84
Molybdenum	0.16

That the increased hardenability is the result of an increased efficiency of chemistry solubility is indicated by both an increase in temperature and the use of a conditioning heat treatment. The increased efficiency of chemistry solubility with increased temperature and conditioning heat treatment is also demonstrated by the resulting higher hardenability of the segregated center section as against that of the outside section of the bar. Owing to segregation, hardenability of the center section is still erratic, and individual hardness values are scattered. In contradistinction to the center, the outside usually produces a comparatively smooth hardenability curve.

Fig. 6. (Left) Photomicrograph (50 X) of outside surface (point E. Fig. 2) of Jominy bar at 0.75 in. from water quenched end. (Vickers hardness indent also shown.) (Center) Natural size photograph of outside surface of Jominy bar. (Right) Sulphur print of surface shown in A and B.



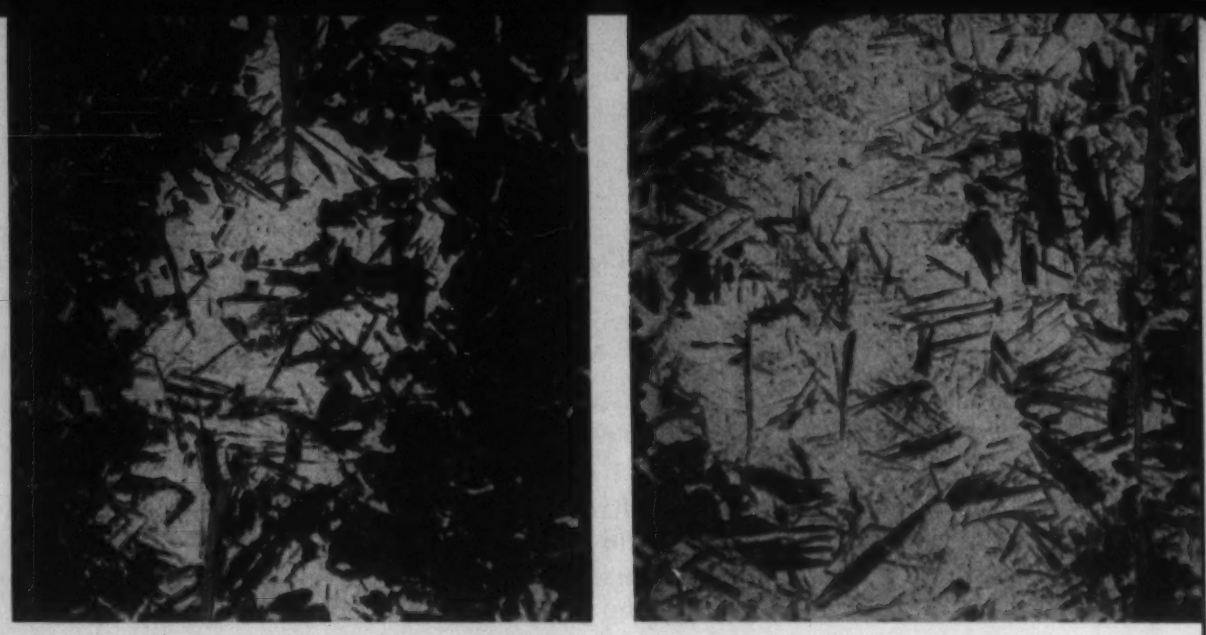
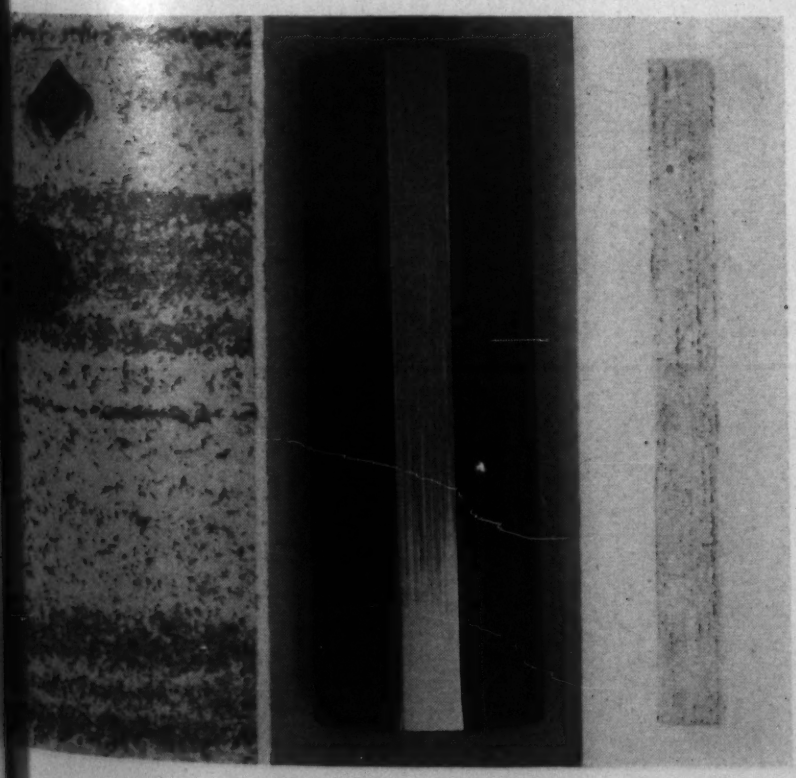


Fig. 8. Bainite and martensite stringers of Fig. 6A at higher magnification and showing sulphide stringers in martensite. Villela's etchant. Mag. 500X.

Fig. 5 shows the Jominy hardenabilities of the center and outside areas of three heats of steel in which the center hardenability was considerably less than the outside. Two of the heats of steel exhibited exceptionally high hardenabilities on the outside. The heat treatment of these bars was as follows: The Jominy bars were packed in cast iron chips and held at 1500 deg. F. for 3 hrs., end quenched in the regular manner, reheated to and held at 1540 deg. F. for 2 hrs., end quenched and surface ground for hardness determinations.

The shape of the center area hardenability and the low hardness values near the quenched end indicate that the center areas were lower in carbon than the areas toward the outside surface. Since the carbon content in the central area is low the hardenability curve could be expected to be lower than for the higher carbon areas.

Fig. 7. (Left) Photomicrograph (50 X) of center surface (point A, Fig. 2) of Jominy bar at 0.75 in. from quenched end. Vickers indentations shown in bainite and martensite stringers. (Center) Natural size photograph of center surface of Jominy bar. (Right) Sulphur print of surface shown in A and B.



Segregation at the Center

Because of the erratic nature of the individual hardness numbers in the center sections, a study was made of the segregation at the center of some of the bars. The data and illustrations are taken from a heat of steel, the analysis of which was reported as follows:

Carbon	0.50
Manganese	0.78
Phosphorus	0.019
Sulphur	0.027
Silicon	0.25
Chromium	0.92
Molybdenum	0.26

Jominy bars were prepared from the radius of the bar stock in accordance with the sketch in Fig. 2. The bars were heated to 1550 deg. F. in cast iron chips, held for 2-hrs. at temperature, and end quenched in the usual manner. Fig. 6 shows the microstructure, macrostructure, and a sulphur print of the Jominy bar surface representing the outside surface of the bar stock. Some segregation and banding is indicated in the structures, and the sulphur distribution is comparatively uniform. Fig. 7 shows the microstructure, macrostructure and sulphur print of the Jominy bar surface representing the center of the bar stock.

Considerable segregation is indicated in the structures, and the sulphur distribution is not uniform and shows considerable segregation. Fig. 7A shows the bands of bainite (dark) and martensite (light). A comparison of Figs. 7B and 7C indicates a close correlation of the position of sulphur segregation and martensitic areas. Fig. 8 at a magnification of 500X shows that the sulphide inclusions tend to lie in the martensitic areas.

Fig. 9 shows the hardenability of the bar stock at the outside, 1/2 in. from the center, and in the center area. The center hardenabilities are plotted for the bainite and martensite transformation products resulting from segregation effects, as shown in Figs. 7 and 8. These areas of different transformation products result from alloy segregation and lack of diffusion when heated above the critical range.

The great amount of segregation found in the 4150 steel is probably produced by the slow rate at which the chromium carbides go into solution in austenite. A considerably more shallow hardening steel of the Amola type, in the same-sized bar, does not produce such a marked degree of segregation and

variation in hardenability as is shown in Fig. 10. The analysis of the steel in Fig. 10 was reported as follows:

Carbon	0.66
Manganese	0.59
Phosphorus	0.017
Sulphur	0.024
Silicon	0.21
Molybdenum	0.33

The microstructure and hardness of segregated areas as shown in Figs. 7 and 9 explain the erratic Rockwell C hardness numbers usually found along Jominy bars representing the center areas of bar stock. The Rockwell C indenter is sufficiently large to overlap transformation products in segregated areas, and the hardness number produced is influenced by the amount of bainite and martensite under the diamond point. The segregation illustrated in Fig. 7 also explains why the hardenability of the center area may show a higher or lower hardenability than the surface.

Extra Care Necessary

Parke and Herzig[1] have demonstrated that homogeneity lowers the hardenability; therefore, the surface of a bar with a more homogeneous structure may show a lower hardenability than the center areas. This is particularly so when the time and temperature conditions of heating produce an increased solubility of the chromium carbides in the segregated areas. W. H. Bruckner[2] has also found that segregation affects the hardenability of carburizing steels.

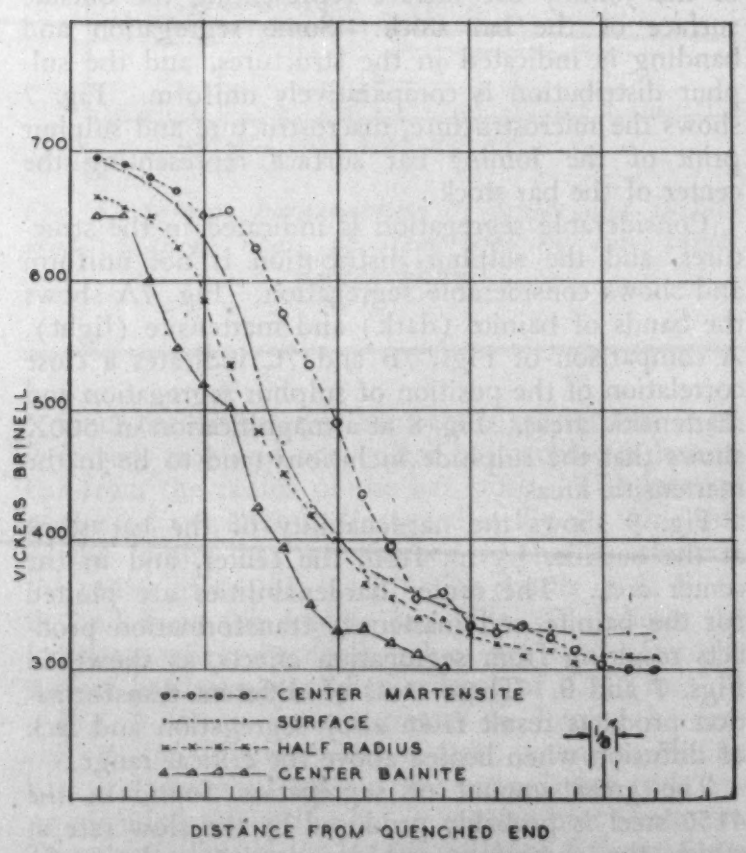


Fig. 9. Hardenability curves for Jominy bar machined from the radius of 2.24-in. bar. Jominy bar was heated at 1550 deg. F. for 2 hrs.

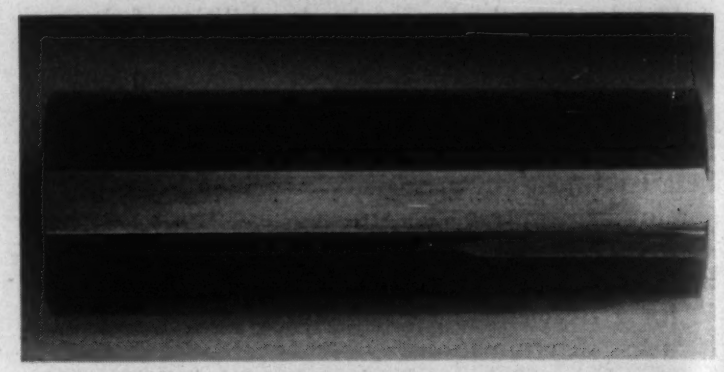
In the manufacture of articles having considerable mass and where it is desirable to have full hardening in the cross section, this method of testing the hardenability is of value and may reveal unsuspected limitations in the hardening capacity of the center area as compared to the outside surfaces.

References

[1] Parke, R. M. and Herzig, A. J. "Hardenability of Steel," METALS AND ALLOYS, Vol. 15, Feb. 1942, pp. 241-244.

[2] Bruckner, W. H., "The Hardenability of Carburizing Steels," Bul. 320, Engineering Experiment Station, University of Illinois.

Fig. 10. Macrostructure and Jominy hardenability of a molybdenum steel.



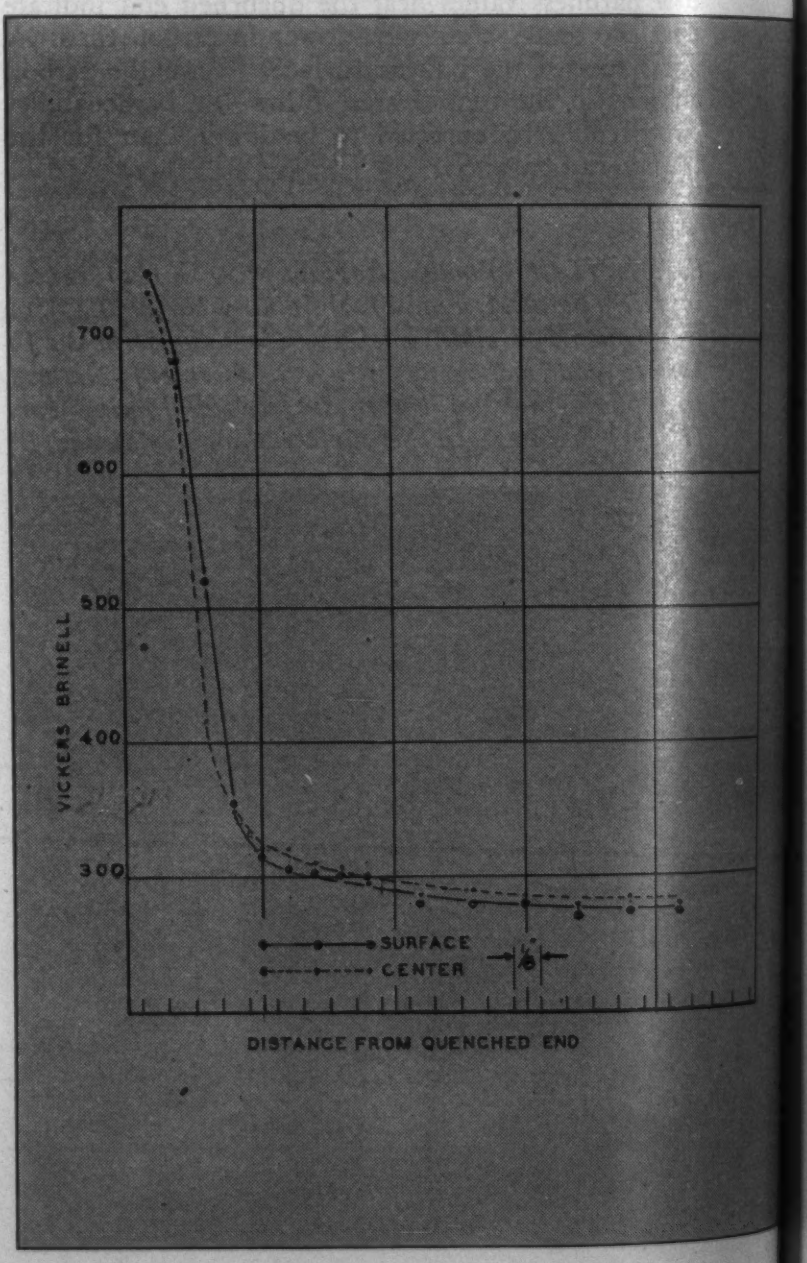


Fig. 1. The molding floor with stacks of molds being made ready for pouring bronze rings.

Piston Rings of Bronze —A Pictorial Article

By TRACY C. JARRETT

Chief Metallurgist, Koppers Co., Amer. Hammered Piston Ring Div., Baltimore, Md.

ONE OF THE GREATEST USES of bronze rings today is in the aircraft industry where they function as oil sealing rings. In the marine field they are used largely in pumps on Liberty ships and other types of cargo ships to prevent corrosion.

The manufacture of piston rings made from gray iron has been described in a previous article (METALS AND ALLOYS, June 1943) and while many of the same operations apply to bronze rings, there are a few which are different.

The physical requirements for a bronze ring are similar to those for gray iron. Bronze rings, however, are not used alone as seals for combustion chambers; there are a few cases, nevertheless, such as the "Gold Seal Ring," where bronze is used in combination with gray iron. This will be described later.

The method of molding and casting of bronze and cast iron rings is essentially the same and is shown in Fig. 1. They do, however, differ in a few respects in that the molds used for casting bronze rings have a large feeder gate. In all cases, bottom pouring is used. Fig. 2.

The melting of the bronze is done in high frequency induction furnaces having a capacity of 210 lbs., and in oil-fired furnaces of 1,200-lb. capacity when exceptionally large rings are made. Fig. 3 shows several of the induction furnaces placed directly in front of the pouring floor. Each individual generator is arranged so that two furnaces can be run from it at one time. The individual furnaces are of the lift coil type, making it possible to use crucibles. A movable table is built to hold two crucibles enabling the operator to melt one charge while the

Fig. 2. A mold for bronze piston rings, showing large feeder gate and sprue hole for bottom pouring.

other crucible is being prepared for melting.

The induction melting of bronze brings about a reduction of melting losses together with a desired mixing action, and by careful weighing of the charges (Fig. 4) a very close chemical control of the finished product is obtained.

The molten metal in the crucible during the melting cycle is covered with borax and a silica sand to minimize oxidation and occlusion of gases. The crucible of molten metal after skimming is poured into ring molds. Fig. 5.

Bronze rings are poured with and without risers, depending upon the ring size and cross-section. Fig. 6 shows a tree of rings with the pouring sprue in the center of one stack. The rings, after the sprues, gates, and risers have been removed, are sand blasted and cleaned ready for the different machining operations.

In the manufacture of bronze rings with tin, nickel, and lead, it is essential that close metallurgical con-

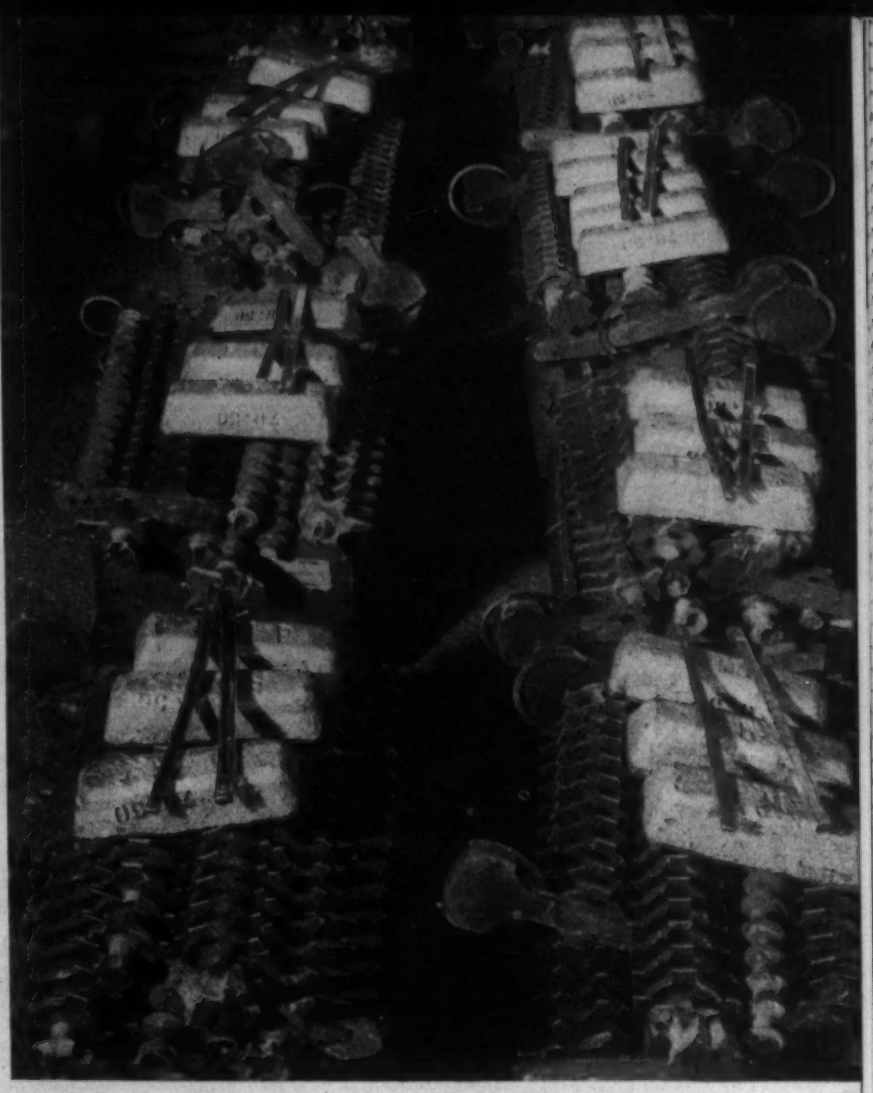


Fig. 4. Furnace charges, foundry returns, pigs and virgin metals carefully weighed ready for melting.

Fig. 3. Induction melting furnaces—each generator operates two furnace coils.

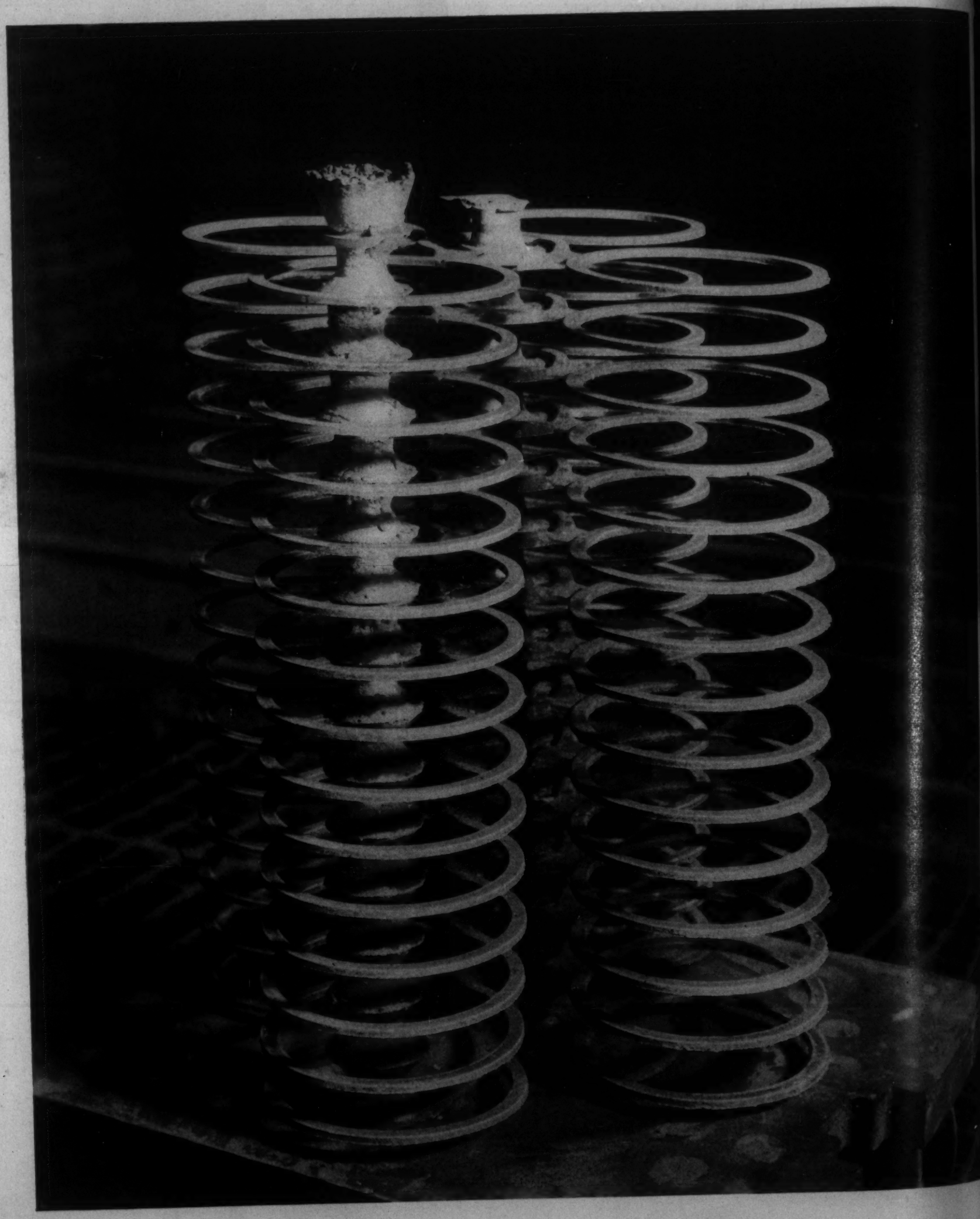


Fig. 6. Ring trees, showing bottom pouring sprue in center of ring stack.

Fig. 5. Pouring molten bronze metal into ring molds.

trol be exercised to meet the specifications for hardness, tension, and other physical properties.

In the daily control of bronze piston rings the molding sand is tested for permeability, moisture, green and dry compression, dry shear, deformation, mold hardness, etc. Every heat of bronze is also analyzed chemically and checked for hardness, porosity, and ability to withstand wear, and also frequent microscopic analyses.

Typical analyses and microstructures of two types of aircraft bronze and bronze rings for railroads are shown in the Table, Columns 1, 2, and 3, and by Figs. 7, 8, and 9.

Typical Analyses of Piston Ring Bronzes

Element	Type 1 Bronze	Type 2 Bronze	Railroad Bronze
Copper	78.0 to 82.0	78.0 to 82.0	86.0 to 90.0
Tin	18.0 to 19.5	15.0 to 17.0	6.0 to 8.0
Lead	0.50 max.	4.0 to 6.0	2.0 to 4.0
Nickel	—	—	1.0 to 2.0
Phosphorus ...	—	—	0.20 to 0.70
Iron	0.50 max.	0.50 max.	0.50 max.
Zinc	0.50 max.	0.50 max.	0.50 max.
Rockwell "B" Hardness ...	85 to 92	72 to 82	
Brinell Hardness	—	—	75 min.

Fig. 7. Structure of Type 1 bronze, 75X. Ammonia persulphate etch.

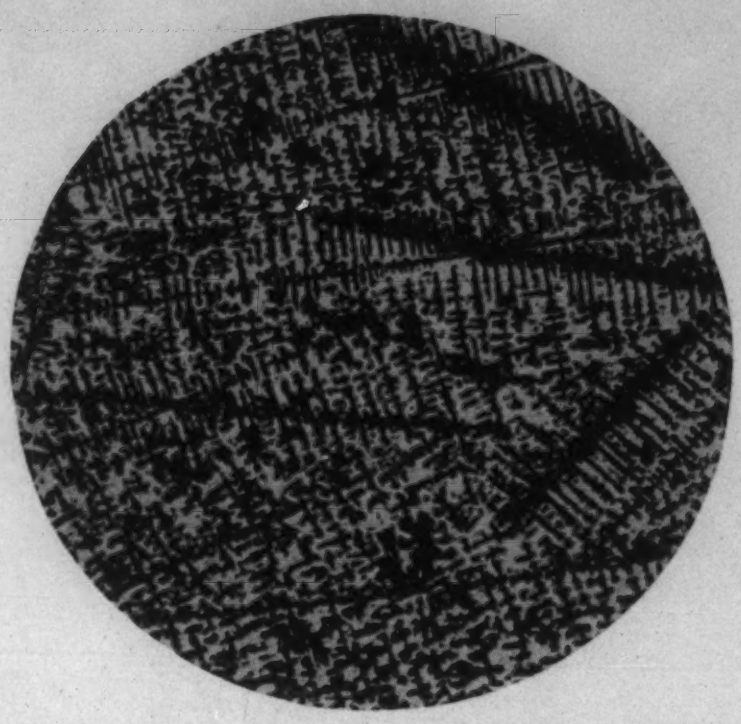


Fig. 8. Structure of Type 2 bronze with high lead content, 75 X. Ammonia persulphate etch.

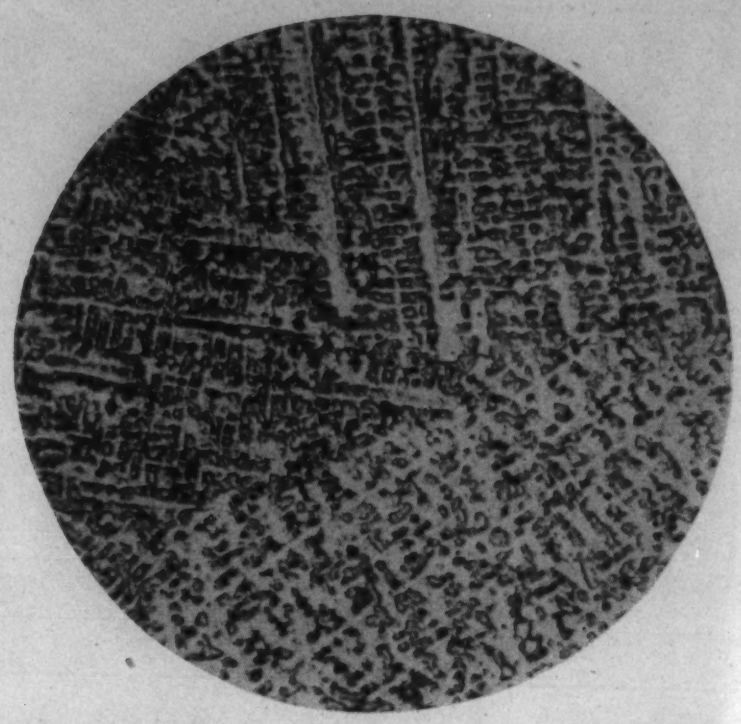


Fig. 9. Structure of railroad bronze, 75 X. Ammonia persulphate etch.

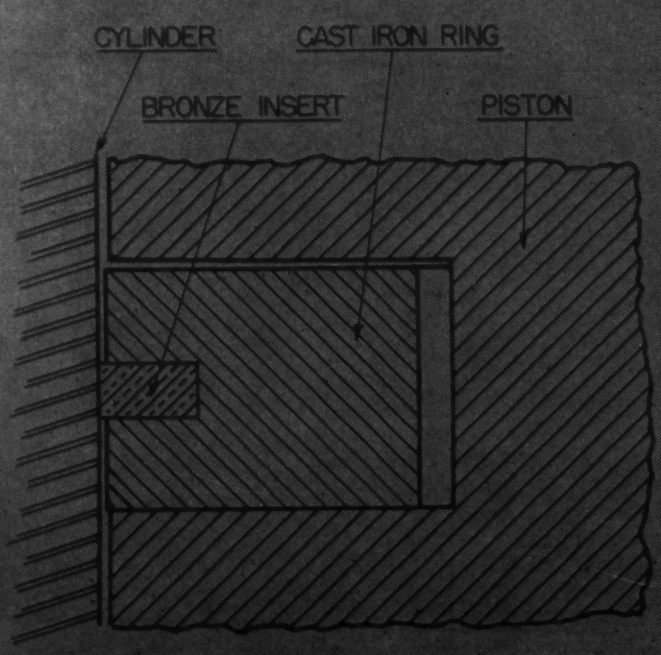
Bronze rings are most widely used as oil sealing rings where operating temperatures are not too high; also in air valves where moisture may be present. There are, however, as mentioned before, installations where a phosphor bronze is used as an inlay in cast iron.

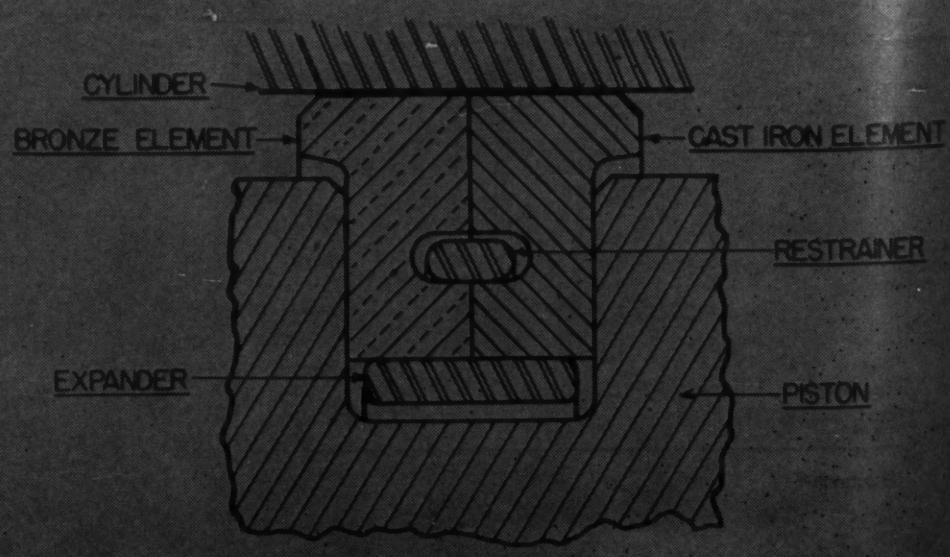
The "Gold Seal Ring" shown in the diagrammatic sketch, Fig. 10, operates satisfactorily in combustion engines, and has frequently been superior to plain gray iron in reducing wear. This ring takes a relatively fast initial seat to the cylinder wall, because of the high unit pressure on the narrow bronze band. This helps to prevent blow-by during the seating-in period. As the bronze insert wears, it burnishes the cylinder wall and allows the cast iron portion of the ring to come to a seat gradually. The bimetallic surface also has a tendency to reduce, and in most cases eliminate scuffing of both ring and cylinder. A typical installation using this ring is a high speed railroad diesel engine.

A bronze-gray iron combination ring, made in segments—sectional sketches, shown in Fig. 11—is used both in the main cylinders and valves of steam railroad locomotives and has proven to be superior to plain gray iron in reducing the rate of wear of rings and cylinders. As shown in the sketch, each of the segments is grooved to receive a restraining ring of steel. An expander ring made of heat resisting alloy steel, forces the cast iron and bronze segments against the cylinder wall.

In many installations, bronze piston rings are essential for efficient operation and, as with cast iron, each application requires individual engineering.

Fig. 10. The "Gold Seal" piston ring. *Fig. 11. A bronze-gray iron combination ring made in segments.*





A woman worker welds studs on a switchgear panel. (Courtesy: General Electric Co.)

Resistance Welding

No. 2: Operating Practice for Various Alloys

by **KENNETH ROSE** METALS AND ALLOYS

The series on resistance welding, which began in the September issue with a review of the machines and processes in general use, continues this month with a discussion of the operating variables (current, time, weld-pressure, etc.) and an outline of accepted practice for the spot and seam welding of the various materials commercially welded. Later instalments will cover precleaning, post-treatment, controls, electrodes, etc.

—The Editors

RESISTANCE WELDING is fundamentally no more than the pressing together of two pieces of metal and heating them locally to fusion by the passage of an electric current. Consideration of the factors influencing this seemingly simple process shows that control of the heat generated and the pressure exerted by the welding machine are obviously needed.

The heat depends upon the current passed, and more particularly upon the density of the current; the resistance from electrode to electrode; and the time of application of the current, along with certain specific properties of the material being welded, such as its thermal conductivity. Pressure is obtained by hydraulic or pneumatic means, or manually in the

smaller types of machines. Springs may be used on some types, especially flash welders. Even when a pressure system has been installed, the static pressure as recorded may differ from the actual pressure during welding, due to the inertia of the moving parts during the fraction of a second the welded metal is in a plastic condition.

The current density may be varied by changing the size or shape of the electrodes, as well as by changing the applied current. Resistance depends upon the specific resistance of the metal being welded, its surface condition, and the pressure applied. The time of application of the current can be quite closely controlled by the mechanical or electrical timers used with the newer types of spot or seam welders.

The welding electrodes and the preparation of the work for welding will be discussed in later articles. After the proper size electrodes have been chosen, and the surfaces of the work properly prepared, there remains the welding pressure, time, and current to be fixed. These are the variables usually considered in setting up a resistance welding job. The timing cycle must include not only the length of time the welding current is applied, but preheating or tempering cycles where these are desired. In the case of butt welding the timing cycle includes application of the current, time of upsetting, and current cut-off.

Welding Carbon and Alloy Steels

Low carbon steel of SAE 1010 grade was the material for about 95 percent of peacetime resistance welding. With the sharp curtailment of steel for civilian use, and the rise of the aircraft industry, aluminum has greatly increased in importance. However, mild steel is still used as the basis for comparisons in most welding operations.

Steel of this grade will have a conductivity equivalent (compared to copper) of about 15 per cent and a melting point of about 2760 deg. F. It has been claimed that, while fusion may occur at the faying surfaces, the metal will weld at temperatures four or five hundred degrees or more below the melting point, due to the wide plastic range of the material and the pressure applied. While steel can be welded over a wide range of temperatures, the pressure required changes considerably also. Lowering the welding temperature 500 deg. F. may make necessary pressures three times as great.

Current timing in general is inversely proportional to the welding current, higher currents making possible shorter timing. Timing is not highly critical with mild steel. The cold rolled metal is preferred for spot and seam welding because of its cleaner surface. When hot rolled stock must be used, and cleaning is impractical, pressures should be increased about 50 per cent, currents held as low as possible, and time increased. This will help to reduce spitting.

The Resistance Welding Research Committee of the American Welding Society, after canvassing steel fabricators and resistance welding equipment manufacturers, has produced tables of recommended conditions for spot and seam welding low carbon steel. These represent the best guides to practice available at present.

When welding steels of a carbon content above 20 points, or containing a few per cent of alloying elements, welding currents should be reduced about 10 per cent because of the higher resistance of these materials. Pressures should be increased about 10 per cent. Current values and timing are more critical than with mild steel.

Steels of these grades show a tendency to weld-harden, and this tendency increases as the carbon content increases. This is due to the high rate at which the steels cool when light gages are being used. Such cooling rates may approximate a thousand degrees a second, so that the weld metal will have received the equivalent of a water quench.

Table I—Recommended Conditions For Spot Welding Low Carbon Steel (Courtesy: Resistance Welding Research Committee, American Welding Society)

Thickness of Thinnest Outside Piece		Electrode size, in.		Net electrode force, lbs.	Weld time, cycles (60 per sec.)	Approx. current, amps.	Minimum weld strength, lbs.	Approx. diam. of fused zone, in.	Minimum overlap, "L" in.	Minimum weld spacing, in.	
"T" in.	gage	Contact diam.	Electrode diam.							2 "T"	3 "T"
0.010	32	1/8	3/8	200	4	4,000	200	0.10	3/8	1/4	1/4
0.020	26	3/16	3/8	300	6	5,500	450	0.13	7/16	3/8	3/8
0.030	22	3/16	3/8	400	8	7,000	800	0.16	7/16	1/2	3/4
0.040	20	1/4	1/2	500	10	8,000	1,200	0.19	1/2	3/4	1.
0.050	18	1/4	1/2	650	12	9,000	1,750	0.22	9/16	7/8	1 1/4
0.060	16	1/4	1/2	800	14	9,600	2,300	0.25	9/16	1.	1 3/8
0.080	14	5/16	5/8	1,100	17	10,800	3,450	0.29	11/16	1 1/4	1 1/2
0.094	13	5/16	5/8	1,300	20	11,500	4,250	0.31	3/4	1 1/2	1 3/4
0.109	12	3/8	3/4	1,600	23	12,000	5,200	0.32	3/4	1 5/8	2.
0.125	11	3/8	3/4	1,800	26	12,600	6,000	0.33	7/8	1 3/4	2 1/2

Table II—Recommended Conditions for Seam Welding Low Carbon Steel (Courtesy: Resistance Welding Research Committee, American Welding Society)

Thickness of thinnest outside piece		Wheel size, in.		Net roll force, lbs.	On-time, cycles (60 per sec.)	Recommended off-time (pressure tight), cycles	Max. weld speed, in. per min.	Welds per in.	Approx. current	Minimum overlap, "L," in.
"T" in.	gage	Contact diam.	Electrode diam.							
0.010	32	3/16	3/8	400	2	1	80	15	8,000	3/8
0.020	26	3/16	3/8	550	2	2	75	12	11,000	7/16
0.030	22	1/4	1/2	700	3	2	72	10	13,000	1/2
0.040	20	1/4	1/2	900	3	3	67	9	15,000	1/2
0.050	18	5/16	1/2	1,050	4	3	65	8	16,500	9/16
0.060	16	5/16	1/2	1,200	4	4	63	7	17,500	5/8
0.080	14	3/8	5/8	1,500	6	5	55	6	19,000	11/16
0.094	13	7/16	5/8	1,700	7	6	50	5.5	20,000	3/4
0.109	12	1/2	3/4	1,950	9	6	48	5	21,000	3/4
0.125	11	1/2	3/4	2,200	11	7	45	4.5	22,000	7/8

Table III—Conditions for Spot Welding "18 and 8" Steel (Two Thicknesses)

Thickness of thinner sheet, in.	Electrode		Weld pressure, lbs.	Weld current, amps.	Weld time, cycles (60 per sec.)
	Dome, in.	Diam. in.			
0.016	1	5/8	275	4,750	3
0.020	1	5/8	350	5,700	4
0.030	2	5/8	500	7,200	4
0.040	4	5/8	750	8,400	5
0.050	4	5/8	1,000	9,200	8
0.062	6	5/8	1,300	10,000	8
0.072	6	3/4	1,600	10,500	8
0.081	6	3/4	1,850	11,000	12
0.093	6	3/4	2,200	11,700	12
0.109	6	3/4	2,500	12,600	15
0.125	8	1	3,000	13,500	15

Because of the varied nature of the work, no one solution can be offered for weld embrittlement. Sometimes an annealing treatment for the entire piece may be indicated. In most cases the condition may be ameliorated by lengthening the welding cycle, so that the cooling rate is slowed down. Recent research has shown that variations of the timing cycle may be used, with pulsations of current to give an annealing effect following the welding impulse. These cycles require specially designed timing circuits.

Stainless Steel

Among the high-alloy steels, "18 and 8" stainless is typical. It presents several problems due to its individual properties, which include a very narrow plastic range, high electrical resistance, low heat conductivity, and possibility of impairment of stainless qualities by improper heating. The electrical and thermal properties make for easy welding, and indeed the metal welds readily under proper conditions. High pressures are required, from about 25 per cent above those for mild steel to two or three times the pressures for that metal.

The quality of the welds is dependent upon accurate control of current and timing. Corrosion resistance of the metal is lowered by heating at 1100 to 1400 deg. F., and tensile strength drops away at temperatures above a critical range varying from about 900 to 1500 deg. F. Unfortunately, it is impossible to learn from the appearance of the finished weld whether this deterioration has occurred, since it results from an intercrystalline precipitation of carbides. The lowering of tensile strength, and of im-

Table IV—Burn-Off Allowances for Flash Welding Mild Steel

Stock thickness, in.	1/16	3/32	1/8	3/16	1/4	3/8	1/2	3/4	1.	1 1/2	2.	4.
Allowance, in.	3/8	7/16	9/16	3/4	7/8	1.	1 1/4	1 3/8	1 5/8	2.	2.	2 1/2
Round stock, in.	1/16	3/32	1/8	3/16	1/4	3/8	1/2	3/4	1.	1 1/2	2.	4.
Allowance, in.	1/8	3/16	1/4	5/16	3/8	7/16	1/2	3/4	7/8	1 1/4	1 5/8	2.

Table V—Machine Setting for Spot Welding Aluminum Alloys

Gage, in.	Time, cyc.	Tip shape ⅜" diam. cone angle	Welding current (amp.)				Electrode pressure	
			2S-O to 2S-H	3S-¼H to 3S-H	52S 53S-W 53S-T	Alclad 24S-T	Min. lbs.	Max. lbs.
0.016	4	7°	15,000	14,000	13,500	14,500	200	350
0.020	6	7°	16,000	15,000	15,000	16,000	250	400
0.025	6	7°	17,500	16,000	16,000	17,500	300	450
0.032	8	7°	19,000	18,000	18,000	19,000	350	500
0.040	8	7°	21,000	19,500	19,500	21,000	425	600
0.051	10	7°	23,000	22,000	22,000	23,000	525	700
0.064	10	7°	26,000	24,500	24,500	26,000	600	800
0.081	12	7°	29,000	27,000	27,500	29,000	700	900
0.102	12	7°	32,500	30,000	31,000	32,000	800	1,050
0.128	15	11°	36,000	33,000	34,000	35,000	900	1,200

Table VI—Machine Settings for Seam Welding 52S Aluminum Alloy

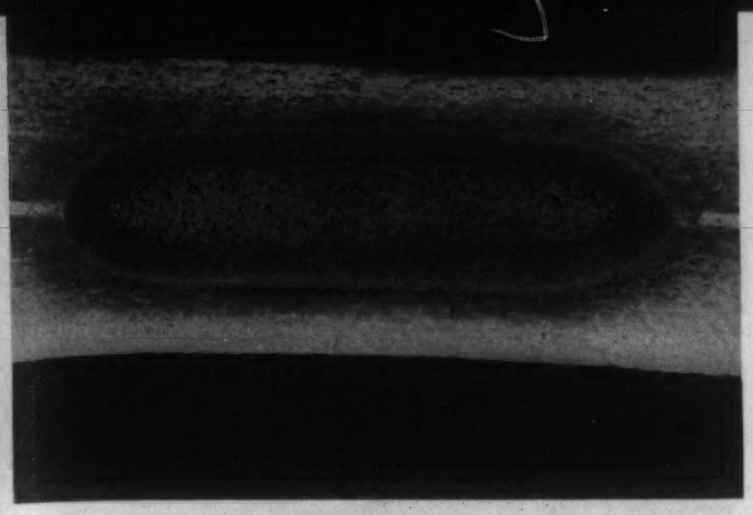
Gage, ins.	Pressure, lbs.	Cycles		Spots, per in.	Approx. welding current, amps.
		On	Off		
0.010	420	½	3	25	19,500
0.016	500	½	3	21	22,000
0.020	540	½	4½	20	24,000
0.025	600	1	6½	18.0	26,000
0.032	680	1	6½	16.0	29,000
0.040	760	1	6½	14.3	32,000
0.051	855	1½	6	12.6	36,000
0.064	960	1½	6	11.3	37,500
0.072	1015	2	5½	10.6	39,000
0.081	1080	3	10½	10.0	40,000
0.102	1210	4	9½	9.0	42,500

pact resistance, ductility and fatigue resistance as well occurs after the structure has been exposed to corrosive conditions, atmospheric or other, and may not be manifest for days or even years.

To pass through these deleterious temperature ranges as quickly as possible very short timing cycles are necessary. It is desirable to heat the metal to welding temperature very rapidly, and to cool it quickly also. Electrodes should be cooled with water or other cooling agent.

The spotwelding of coated steels offers no great difficulty, although factors other than weldability may require consideration. Chrome-plated steel is not usually spotwelded because of the inevitable marring of the surface, which is too thin to permit repolishing. Nickel plated steel, having a somewhat heavier plating, may be refinished.

Steels coated with metals of lower melting point, such as terne plate, tin plate, galvanized sheet, cadmium plate and aluminum-coated stock weld with-



Spot weld in two thicknesses of 1/8-in. 24 ST Alclad. This weld was produced on what is claimed to be the world's largest spotwelder, at the plant of the Glenn L. Martin Co., with 240 kw. capacity. (Courtesy: Sciaky Bros.)

out trouble. The coating will melt directly under the electrodes, and hold time (current off) should be increased to permit this fused metal to re-solidify. In the case of zinc coatings it is helpful to increase both pressure and current to hasten the welding and reduce loss of zinc. Pressures for all these coatings should be 10 to 20 per cent higher than that used for mild steel.

The flash- and upset-butt welding of the mild, carbon, and alloy steels has not been standardized to the same extent as spot and seam welding, due to the wide variation in form which the work may take. The processes and the machines therefor have been described in the first article in this series (M&A for September, 1943, page 518). Flash welding is the more widely applicable of the two processes, and is the more generally used. In both, the work is upset a predetermined amount. The diagram of a flash welding cycle illustrates the timing. Burn-off, as shown, is equal to the total movement of the dies, the first part of the cycle being the arcing, or flashing, stage as the two ends of the work are brought together; a short circuit current as the ends meet; an upsetting stage as pressure is increased to forge the two ends together, and current cut-off. Current cut-off may be made simultaneous with the start of upsetting. During the flashing stage the dies are brought together at a rate equal to the burning away of the metal.

Mild steels may be flash welded without difficulty. The high carbon and alloy steels may frequently be flash welded with less trouble from embrittlement than in spot welding. Stainless steel (18 and 8) is readily flash welded, using a shorter cycle than for low carbon steel. Considerable difficulty is encountered in welding 18 and 8 metal by the upset-butt process.

Aluminum and its Alloys

While it may be possible to weld steel at a temperature below its fusion point, aluminum and its alloys must be melted in the welding process. The molten state exists only at the inner contacting surfaces, the outside surfaces remaining relatively cool. The aluminum alloys all have low electrical resistance, low melting point, short plastic range, good thermal conductivity, and tendency to form a very thin, tightly adherent oxide film over exposed surfaces—a combination of conditions requiring accurate control of short welding cycles, at high currents. Aluminum requires about five times the current used in welding low carbon steel.

There are dozens of aluminum alloys, but those with which the resistance welder is concerned are of three types—2S or commercially pure aluminum; the strain-hardening alloys, of which 3S and 52S are typical, and the heat-treatable alloys, which may be represented by 17S, 24S, and 53S. In addition, the alloys may be obtained as clad metals, in which a coating of pure aluminum protects the stronger but less corrosion-resistant base metal, such as Alclad or Pureclad 17S and Alclad or Pureclad 24S. All of these materials can be resistance welded under the proper conditions.

The following list of electrical conductivities of common aluminum alloys, given as per cent of International Copper Standard, is a useful guide to welding set-ups:

Alloy	Specific Gravity	Per Cent Conductivity
2S-O	2.71	59
2S-H	2.71	57
3S-O	2.73	50
3S-H	2.73	40
52S-O	2.67	40
52S-H	2.67	40
53S-O	2.69	45
53S-W	2.69	40
53S-T	2.69	40
17S-T	2.79	30
24S-T	2.77	30

The heat-treatable alloys are more critical in their requirements for high quality spot and seam welds than the other compositions. Current values must be correct and closely controlled, and timing should be accurate and synchronized with the alternations of the welding current. Pressures must be properly chosen, and the pressure mechanism quick acting to follow through during the short period when fusion occurs.

For all types it is preferable that the electrodes close upon the work without a hammer blow, to avoid marring the surface. One electrode should be flat-faced while the other may be ball-pointed or domed. The fused portion of the metal, ellipsoidal in shape, should be about two-thirds of the total thickness of welded material.

A structure representing cast metal is exhibited by the button in welded aluminum alloys.

The casting alloys may be resistance welded also, and this is done with cast aluminum kitchenware.

Seam welding ordinarily utilizes the strain-hardening alloys, or pure aluminum, since they suffer less

Two men are welding an aircraft part, illustrating the variety of sizes and shapes of material that can be spotwelded. (Courtesy: Consolidated Aircraft Corp.)

loss of ductility of the weld. The width of the weld should be about twice the thickness of the material welded plus 1/16 in. When a pressure-tight seam is to be made, the ordinary ratio of "on" time to "off" time is from one-to-three to one-to-five. The speed of the rolls is then adjusted to get the required number of spots per inch. Machine settings for seam welding one alloy are given in Table VI.

When the seam need not be pressure-tight, uniformly spaced spot welds may be made with the seam welder. The "on" time may be about half that for the pressure-tight seam, with wheel speed adjusted to give the desired weld spacing.

Upset- or flash-butt welds may be made with the aluminum alloys. The latter process is more generally used. Currents must be considerably higher than for steel. Flashing allowance for tubing and small work may be from 1/4 to 1/2 in., with 1/16 to 3/16 in. for upsetting. The allowance for upsetting is, in general, about equal to the thickness of the section welded.

Magnesium Alloys

Magnesium alloys are comparatively new in the resistance welding field, but they are being welded satisfactorily. They possess welding characteristics similar to those of aluminum. Electrical conductivity, as per cent equivalent copper, is given below for several of the most common alloys.

Pressures required are equal to or slightly higher than those for similar sizes of aluminum. Currents are considerably lower, as the greater resistance would indicate. Sheet stock has been successfully spot welded to castings of 1/4 in. wall thickness.

Gas-tight seams may be made in magnesium alloy structures with conventional seam welders, although a flood of water is usually necessary to keep down buckling. Butt welding of the alloys requires currents higher than for steel. Best results are obtained with a modified flash welding process, in which, after preliminary flashing, an upsetting cycle occurs. The metal becomes hot short just below the melting point.

Alloy	Pure Magnesium	Am-240-C Dow G	Am-3-S-O Dow M	Am-C-52-S-H Dow F	Am-C-58-S Dow O
% Conductivity	39.0	11.5	34.5	17.2	10.8

Table VII—Machine Settings for Spotwelding Magnesium Alloys

Sheet thickness, in.	Electrode pressure, lbs.	Time in cycles (60 per sec.)	Welding current, amps.
0.020	200-500	1-4	10,000-17,000
0.040	400-700	5-8	20,000-25,000
0.064	600-900	9-12	25,000-30,000
0.081	800-1200	12-16	30,000-35,000
0.128	1000-1500	16-20	35,000-45,000

Copper and its Alloys

Pure copper sheet can be spot welded in sheets up to about 1/16 in. in thickness. Since the work offers no greater resistance to the passage of the current than the electrode material, and frequently less, considerable difficulty is to be expected from sticking electrodes. This may be minimized by using electrodes faced with tungsten or molybdenum, which will not weld with the work. The quality of the welds is always in doubt.

The copper-base alloys exhibit welding properties varying with the percentage of alloying elements, as might be expected. Of the brasses, weldability increases with increasing zinc content, which parallels the increase of electrical resistance. The phosphor bronze and nickel silvers show even better weldability, with lower current requirements. The input for welding brass of 0.036 in. thickness may be from 80 to 150 kva, while bronzes would require only 60 to 110 kva.

The silicon bronzes such as Everdur, Herculoy, Duronze, Olympic bronze, etc., are most readily welded of all the copper alloys. Their electrical conductivity is only 5 to 15 per cent standard equivalent copper. The resulting welds have good strength characteristics.

When resistance-weldability is an important factor in selection of a copper-base alloy, addition of about 2 per cent Si to the composition may be desirable because of the greatly increased resistance resulting.

Electrode pressures for all the copper alloys should be from 10,000 to 20,000 lbs. per sq. in.

Butt welding of brasses requires much greater power than for steel. Weldability increases with increasing zinc content.

Special Materials and Combinations

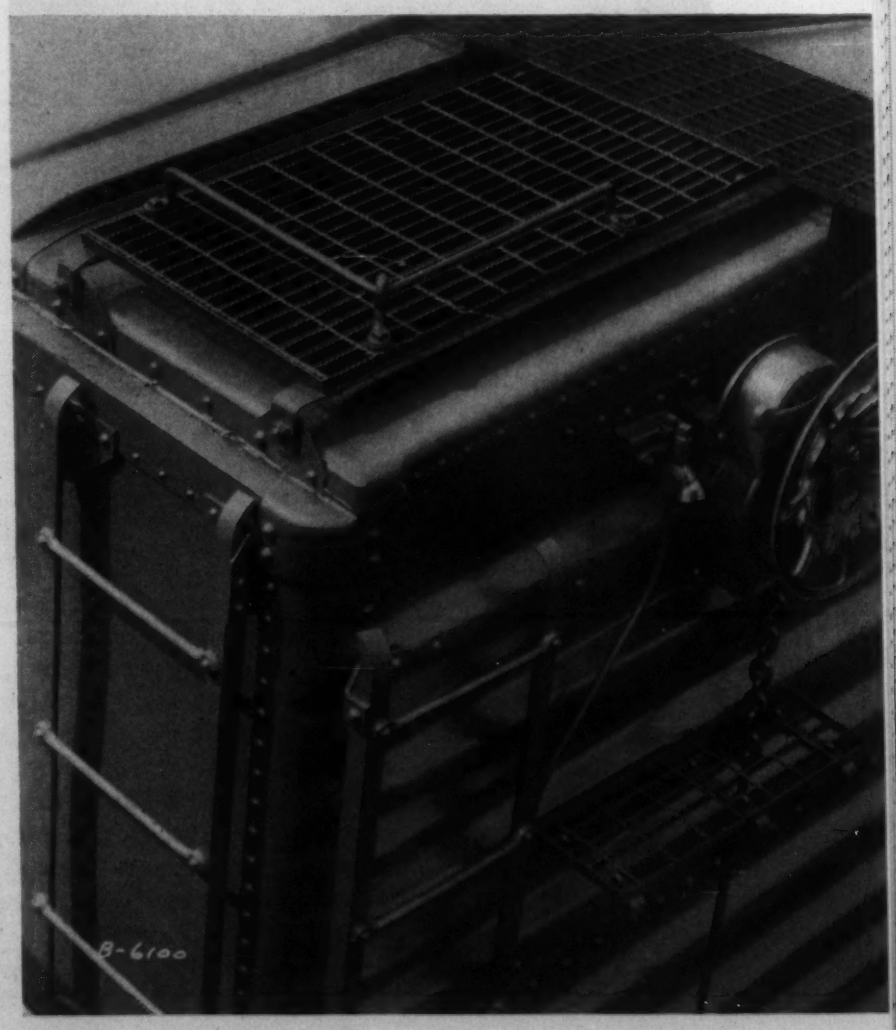
Alloys of nickel show high resistivities, and can be successfully welded. Those of high nickel content exhibit hot-shortness in a range of temperatures between about 1450 and 1650 deg. F., and must be handled with care to avoid stressing while in this state. This is overcome by supporting the work while welding.

Monel metal, Inconel, etc., require less current for welding than mild steel, while commercial nickel requires slightly higher values. Electrode pressures are of the same order as for steel. Cleanliness of the metal surfaces is important if successful welds are to be obtained.

It is frequently important to weld together dissimilar metals, as in the flash welding of high speed steel tools to low carbon shanks, or stainless steel to mild steel. The test for weldability of such combinations is whether the two elements could form a usable alloy. In general, ferrous alloys can be welded in practically all combinations. Of the non-ferrous metals, intermediate alloys may be formed at the weld zone with the proper combinations, to give a weld which will pull a button, or a stick weld may result, in which the surfaces adhere without there being any alloying of elements. These stick welds have no usable strength, and break at the interface of the metals without pulling a button.

Flash welding is especially useful in making these otherwise impossible combinations. Experimental welds of lead and platinum have been made by the flash process. A careful balancing of conductivities and cross-sectional areas is necessary in welding these combinations of dissimilar metals, to equalize resistances and prevent one of the metals from being consumed before the other can be brought to welding temperature.

Resistance welding makes non-slip footboards for freight cars. These parts are electroforged from crossed strips of steel to provide a durable replacement for wooden walk-ways. (Courtesy: Blaw-Knox Co.)



Engineering Alloys Containing Calcium

by C. L. MANTELL and CHARLES HARDY

Consulting Engineer and President, Hardy Metallurgical Co., respectively

In view of calcium's wide use as a deoxidizer and scavenger in the refining of liquid metals, it is easy to forget its many applications as an important ingredient of engineering alloys that serve as materials of construction. This article presents, therefore, an easy-to-use tabulation of engineering alloys containing calcium, giving data on compositions, properties, uses, patents, etc.
—The Editors

A piece of highly pure metallic calcium produced by redistillation.

ALTHOUGH METALLIC CALCIUM by itself has no engineering uses as a material of construction, it is a highly important component of a variety of industrial alloys. In many cases the properties of such alloys are markedly improved by even a tiny addition of calcium metal.

Calcium's applications may be roughly divided into (1) those of a *metallurgical refining* (deoxidizing, desulphurizing, degasifying, etc.) nature and (2) those wherein the calcium functions as an *alloying agent,* conferring improvement by virtue of its final presence in the alloy in question. The refining type of applications have been discussed in an article in METALS AND ALLOYS for February and March, 1939. Many new uses of this type and a host of calcium master alloys therefor, many of a proprietary nature, have been developed since that time. Inasmuch, however, as a large proportion of such applications to the deoxidation, "intensification," grain refinement and "modification" of ferrous and non-ferrous alloys are still confidential they will not be reviewed in this article, which comprises chiefly a tabulation of compositions and general properties and uses of calcium-containing alloys as materials of construction.

Of all the alloys of calcium, those with lead are at present the most investigated because of the great improvement in the strength and creep resistance that a small percentage of calcium produces in lead. Thus the time-honored material for cable sheaths is a lead alloy with 1% Sb. A lead-calcium alloy, however, with as little as 0.4% Ca is considerably superior to the old standby in hardness, tensile strength and fatigue resistance, and is used to an ever-increasing extent.

Similarly lead-calcium alloys (0.1% Ca) are replacing lead-antimony alloys with 9% Sb for storage battery grids owing to the improved resistance to sulfation of the calcium alloy and other advantages. Several efforts have also been made to develop lead-calcium alloys as bearing metals, with occasional success.

Magnesium alloys are increasing in general engineering importance, and calcium is also a component of many of these. In most cases where used, calcium is present along with other alloying elements. In such alloys calcium improves the grain structure, workability or corrosion resistance.

The effect of small calcium contents on the grain structure, heat resistance and service life of nickel alloys used for electric heating elements and other applications has been exploited by manufacturers of such materials to produce resistance elements with several times the service life of electrical heating alloys available 12 or 15 years ago. Calcium has also been found to be a useful ingredient in improving the hardness and other properties of platinum, gold and silver alloys used for jewelry and dental work.

The engineering alloys of calcium whose compositions have been published in either the patent or technical literature are presented in the accompanying tables, which give the compositions, properties, uses and the pertinent literature reference (or trade name) for each alloy. To save space some abbreviations have been used, *e.g.* U.S.P. for United States patent, B.P. for British patent, C.P. for Canadian patent, F.P. for French patent and G.P. for German patent.

LEAD ALLOYS CONTAINING CALCIUM

COMPOSITION									Outstanding Property	Chief Application	Reference or Name
Ca	Al	Cu	Li	Mg	Na	Pb	Sn	Others			
0.04	—	—	—	—	—	Bal.	—	—	good fatigue and tensile strengths	cable sheaths	Metals and Alloys, 1, 1930, p. 405
0.10	—	—	—	—	—	Bal.	—	—	resistance to sulfating	storage battery grids	Trans. Electrochem. Soc. 68, 1935, p. 292
0.02	—	—	—	0.02	—	Bal.	0.02	—	high strength and creep resistance	cable sheaths	"Tubeloy"; Metals and Alloys, 15, 1942, p. 86
0.60-0.73	0.1-0.2	—	0.03-0.04	—	0.58 0.62	98.3-98.7	—	—	saves tin	railway bearings	German alloy "Bahnmetall"
0.03-3.0	—	—	—	0.01-0.03	—	96.7-99.96	—	—	3 Ca alloy has high hardness and strength	storage battery grids	C.P. 384,675
1.0 1.5	—	—	—	—	0.01-	99.0-99.5	—	—	—	—	F.P. 833,471
0.01-0.1	—	—	—	—	—	99.64-98.15	0.35-1.75	—	—	—	U.S.P. 2,159,124
2.7-2.9	—	—	—	—	0.45	96 55-96.85	—	—	—	—	Z. Metallkunde, 30, 1938, p. 52
0.13-0.10	—	—	—	—	trace	99.87	—	—	—	—	Z. Metallkunde, 30, 1938, p. 52
0.10-10.0	—	6	—	—	—	Bal.	—	—	—	—	G.P. 584,399
0.3-1.0	0.02-1.0	—	0.02-0.22	0.02-0.22	—	95.24-99.07	0.5-2.0	0.1-0.5 Hg, 0.02-0.22 K	—	—	B.P. 374,003
0.02	0.05	—	—	—	—	98.65	1.0	0.1 Hg	—	—	C.P. 321,681
0.02-0.1	—	—	—	—	—	Bal.	—	—	—	—	B.P. 356,801
1.0	—	—	—	—	—	99.0	—	—	—	—	C.P. 306,610
0.35	—	0.5	—	—	0.4	98.45	—	0.3 Sr	—	bearings	British alloy "Can"
2.0	—	—	—	1.5	—	96.3	—	—	high hardness and fatigue resistance	bearings	"Union Bearing Metal"
0.6	—	—	—	—	trace	96.75	2.5	2 Ba, 0.15 Hg	—	bearings	"Satco Metal"
2	—	—	—	—	—	—	—	1 Ba	—	bearings	"Frary Metal"

ALUMINUM ALLOYS CONTAINING CALCIUM

COMPOSITION									Outstanding Property	Chief Application	Reference or Name
Ca	Al	Bi	Cu	Mg	Mn	Ni	Sb	Others			
0.55	Bal.	—	—	—	—	—	—	—	corrosion resistance	cladding over dural	Z. Metallkunde, 32, 1940, p. 363
0.2	98	—	—	1	—	—	—	0.8 Si	high conductivity, strength	high tension lines	German alloy "Montegal"; Chem. Age, 47, 1942, p. 107
1.0-1.5	Bal.	—	—	1.4-1.6	2.5-3.2	—	—	0.25-0.40 Cr, 0-0.3 Fe, 2.2-2.7 Si	strength after age-hardening	piston forgings	B.P. 517,731
0.5-5.0	Bal.	—	0.5-2.0	0.5-3.0	1-7	0-1.7	—	0-0.3 Cr, 0-1.7 Fe, 1-7 Si, 0-0.5 Ti	(Cu+Ni<3%; Ni+Fe or Cr<2%)	forged pistons	B.P. 517,731
0.01-2.0	Bal.	0.05-0.4	—	2-15	—	—	0.05-0.4	—	—	—	C.P. 348,148
0.01-2.0	Bal.	0.05-0.4	—	2-10	—	0.2-5.0	0.05-0.4	—	—	—	C.P. 348,148
0.01-2.0	Bal.	0.05-0.4	—	3-8	0.5-4.0	0.5-4.0	0.05-0.4	—	—	—	C.P. 348,148
0.01-2.0	Bal.	—	—	5-15	—	—	—	0.01-1.25 Pb, 0.01-1.25 Sn	—	—	F.P. 790,872
0.1-2.0	Bal.	—	5-20	—	1-3	0.1-3.0	—	1-3 Cr, 1-3 W	Ca replaceable by Sn, Ba, Be, Na, K, Li	—	B.P. 353,891
0.2-5.0	Bal.	—	—	0.2-10*	0.2-2*	0.2-5*	—	0.2-5 Be, 0.1-1 Cr*, 3-5 Si, 0-3 Sn, 0.3-2 V	(*composition includes one or more of these)	—	G.P. 535,345

Aluminum Alloys Containing Calcium (Cont.)

COMPOSITION									Outstanding Property	Chief Application	Reference or Name
Ca	Al	Bi	Cu	Mg	Mn	Ni	Sb	Others			
0.01-2.0	Bal.	0.05-0.4	1-6	2-15	0.5-4	—	0.05-0.4	0.5-3 Cr, 0.1-1.0 Mo, 0.1-1 Ti	(also contains 0.1-1 V, W and Zr)	—	B.P. 428,363
0.1-2	Bal.	—	—	1-8	—	—	—	0.5-6 Zn	—	—	U.S.P. 1,932,836
0.2	95.3	—	—	4	0.5	—	—	—	—	—	U.S.P. 1,932,837
0.05-2	Bal.	—	—	2-10	—	0.2-5	—	—	—	—	U.S.P. 1,932,854
0.05-2	Bal.	*	*	2-10 or 3-8	*	0.2-5	*	Mo*, Co*	*Constituents present separately or in combination in amounts specified in patents.		U.S.P. 1,932,855-857 1,932,859-861 1,932,864-865 1,932,868
0.05-2.0	Bal.	0.05-0.4	0.5*-5	2-15 or 3-8	—	—	0.05-0.4	0.5-3.5 Cr*, 0.1-3.5 Co*	*These constituents present singly in 1,932,862-7-9, respectively. All absent from 1,932,858		U.S.P. 1,932,858,-862,-867,-869
0.05-2.0	Bal.	—	0.5-6	3-8	—	—	—	0.5-5.0 Co*	*Co present only in 1,932,853		U.S.P. 1,932,853,-856

MAGNESIUM ALLOYS CONTAINING CALCIUM

COMPOSITION									Outstanding Property	Chief Application	Reference or Name
Ca	Ag	Al	Cd	Ce	Mg	Mn	Zn	Others			
0.1-0.2	—	0.3	—	—	97.7	2	—	—	increased strength, lower inflammability	aircraft parts	"Magnewin," Z. Metallkunde, 31, 1939, p. 302
0.5-1	—	—	3	—	96-96.5	—	—	0.5-1 Hg* 0.5-1 Se*, 0.5-1 Sr*, 0.5-1 Te*	improved corrosion resistance	*(present singly or in pairs)	Tetsu-to-Hagane, 24, 1938, p. 34
0.2	2.5-3	8-8.5	—	—	Bal.	0.4	—	—	high strength; better heat treating properties	precipitation-hardened parts	Chem. Age, 47, 1942, p. 107
1	—	8	—	—	Bal.	—	—	—	better casting properties	strong castings	Eng. & Tek (Russ.), 1936, p. 670
0.1-2	—	—	0.1-10	—	Bal.	—	0.1-10	0.1-5 Pb	good hot workability	rolled shapes, sheets and extrusions	F.P. 730,088
0.05-1.0	0.3-10	—	—	—	Bal.	—	0.1-4	—	—	—	B.P. 544,350
0.05-0.5	—	—	3-7	0.1-0.7	Bal.	1.5*-2.5	—	—	good workability *(present in 2,286,866)	sheet products	U.S.P. 2,286,866,-867
0.01-1.0	—	—	—	0.01-0.1	Bal.	—	—	1-15 Tl	good workability	sheet products	U.S.P. 2,286,870
0.05-1.0	—	—	—	—	Bal.	—	—	0.5-12 Cu	good workability	sheet products	U.S.P. 2,221,245
0.05-1.0	0.3-8	—	—	—	Bal.	0.1-3.0	0.1*-8	0.1-8 Sn	(*present in 2,221,248 only)	properties and applications same as above	U.S.P. 2,221,248 and -249
0.05-1.0	—	—	—	—	Bal.	—	—	0.1-10 Tl	good workability	sheet products	U.S.P. 2,221,250
0.01-1.0	0.1-2	—	—	—	Bal.	—	—	—	good workability	sheet products	U.S.P. 2,232,922
0.01-1.0	—	—	—	—	Bal.	—	—	1-10 Ni	good workability	sheet products	U.S.P. 2,233,008
0.01-1.0	0.3-10	0.3-10	1-15	—	Bal.	—	—	—	good workability	sheet products	U.S.P. 2,233,265
0.01-1.0	—	0.3-12	—	—	Bal.	—	—	1-20 Tl	good workability	sheet products	U.S.P. 2,233,953
0.01-1.0	—	—	—	—	Bal.	—	0.3-8	1-20 Tl	good workability	sheet products	U.S.P. 2,233,959
0.05-1.0	0.3-12	—	—	—	Bal.	0.1*-3	0.1*-10	—	*(Zn and Mn present together only in 2,221,247 and -259)	properties and applications: as above	U.S.P. 2,221,243, -245, -247, -251, -252, -256, -259
0.1-5	—	—	—	1-12	Bal.	0.1-4	—	1-4 Co (optional), 1-4 Ni	—	—	B.P. 472,771

Magnesium Alloys Containing Calcium (Cont.)

COMPOSITION									Outstanding Property	Chief Application	Reference or Name
Ca	Ag	Al	Cd	Ce	Mg	Mn	Zn	Others			
4-6	1.5-3	6-8	—	—	Bal.	4-6	4-6	—	good tensile properties	—	U.S.P. 2,126,010
0.1-2	—	1-15	—	—	Bal.	0.1-1	—	0.5-22 Pb	good corrosion resistance	—	U.S.P. 2,026,592
0.1-2	—	—	1 10*	—	Bal.	—	1-10*	0.5-22 Pb	good casting, heat treating behavior	*(Zn in 2,045,237, Cd in -239)	U.S.P. 2,045,237 and -239
0.05-2	—	—	—	—	Bal.	—	2-6	4-8 Sn	good workability	heat treated parts	U.S.P. 1,914,588
0.05-2	—	—	—	—	Bal.	0.1-2.5	0.1-10	0.1-20 Sn	good workability	heat treated parts	U.S.P. 1,914,589

NICKEL ALLOYS CONTAINING CALCIUM

COMPOSITION									Outstanding Property	Chief Application	Reference or Name
Ca	Al	C	Ce	Cr	Fe	Ni	Zr	Others			
0.02-2.0	—	—	0 02-2.0	10-30	0-50	Bal.	—	—	improved service life	resistance and heating elements	F.P. 848,129
0.01-0.20	—	—	—	15-25	—	Bal.	0.1-1.0	1-20 Mo	increased useful life	electric heating elements	U.S.P. 2,005,430
0.01-0.2	0.01-1.0	—	—	15-25	—	Bal.	0.01-0.5	—	increased useful life	electric heating elements	U.S.P. 2,005,431
0.01-0.2	—	—	—	10-18	17-30	Bal.	0.1-1	1-20 Mo	increased useful life	electric heating elements	U.S.P. 2,005,432
0.01-0.2	0.01-1.0	—	—	10-18	17-30	Bal.	0.01-0.5	—	increased useful life	electric heating elements	U.S.P. 2,005,433
0.5-10	—	0.05-1	—	—	—	Bal.	—	—	hardenability	tool material	U.S.P. 1,986,585

OTHER ALLOYS CONTAINING CALCIUM

COMPOSITION									Outstanding Property	Chief Application	Reference or Name
Ca	Al	Cr	Cu	Fe	Ni	Pt	W	Others			
0.05-2	—	10.5-35	—	Bal.	13-30	—	—	—	heat- and electrical-resistance	resistance elements	B.P. 511,494
0.01-2	5-30	—	—	5-45	—	—	—	One or more of: Co, Cr, Cu, Mn, Mo, Ti, V, W, Zr, C, Si, P, Pb	special magnetic properties	permanent magnets	F.P. 817,547
1	14.5	—	—	60.5	24	—	—	—	special magnetic properties	permanent magnets	F.P. 817,547
*	—	—	—	0-50	20 min.	—	—	0.02-1.2 Ce*; 1+Co; Mg+W< 20; 0.01-6 Th*	*(Ce and Th can be partly replaced by Ca)	resistance elements	B.P. 510,236
0.02-5	—	—	0-10	—	—	—	—	Bal. Ag	good electrical and wear properties	electrical contacts	U.S.P. 2,199,458
0-10	1-10*	1-10*	—	1-10*	1-10*	Bal.	1-10*	1-10 Ta*	*(optionally present, single or combined)	hard jewelry and dental alloys	G.P. 535,688
0-10	—	—	—	—	—	5-25	—	Bal. Au	hardenability	jewelry and dental	G.P. 535,688
0.1-5	—	—	—	—	—	Bal.*	—	*(Pt can be replaced with Pt-base alloy)	lowered volatility	high-temperature furnace elements	G.P. 589,449
0.1-1	—	—	94-99	—	—	—	—	0.1-5 Zr	increased hardness	contacts, electrodes, etc.	B.P. 512,142, -143
0.4	—	—	Bal.	—	—	—	—	—	increased strength	conductors	Trans. A.I.M.E., 1930, p. 141

Pressing and Sintering Carbide Tool Tips

By W. T. MUIRHEAD

Vice President and Gen. Mgr. A. C. Wickman, Ltd., Toronto, Canada

One of the major engineering contributions to Victory in this war has been the tremendous expansion in the use of sintered carbide tools for the highest-speed machining of steel and other materials. The tools are made by brazing carbide tips to a steel or cast iron shank. The manufacture of these tips, described in this article, is a major application of powder metallurgy. The author gives special attention here to the presses and dies employed.

—The Editors

MANY OF OUR HIGH-PRODUCTION records in the manufacture of munitions are directly traceable to the use of cutting tools made of the extremely hard carbides of tungsten, tantalum and titanium in various mixtures or combinations. The tools contain only a relatively small amount of the carbides, as the latter are formed into a tip, which is then brazed to a strong supporting shank material like steel or cast iron.

The still relatively expensive nature of the tungsten carbides is a second reason for supplying it in small nibs or tips, which are brazed to the surfaces of ordinary steel or even high strength cast iron shanks. Two considerations must be satisfied in this respect—the shank or body of the tool must be properly recessed to receive the tip, and the tool must be rigidly supported in the machine. Brazing, using only copper sheet in the joint, is amply strong to hold the tips securely.

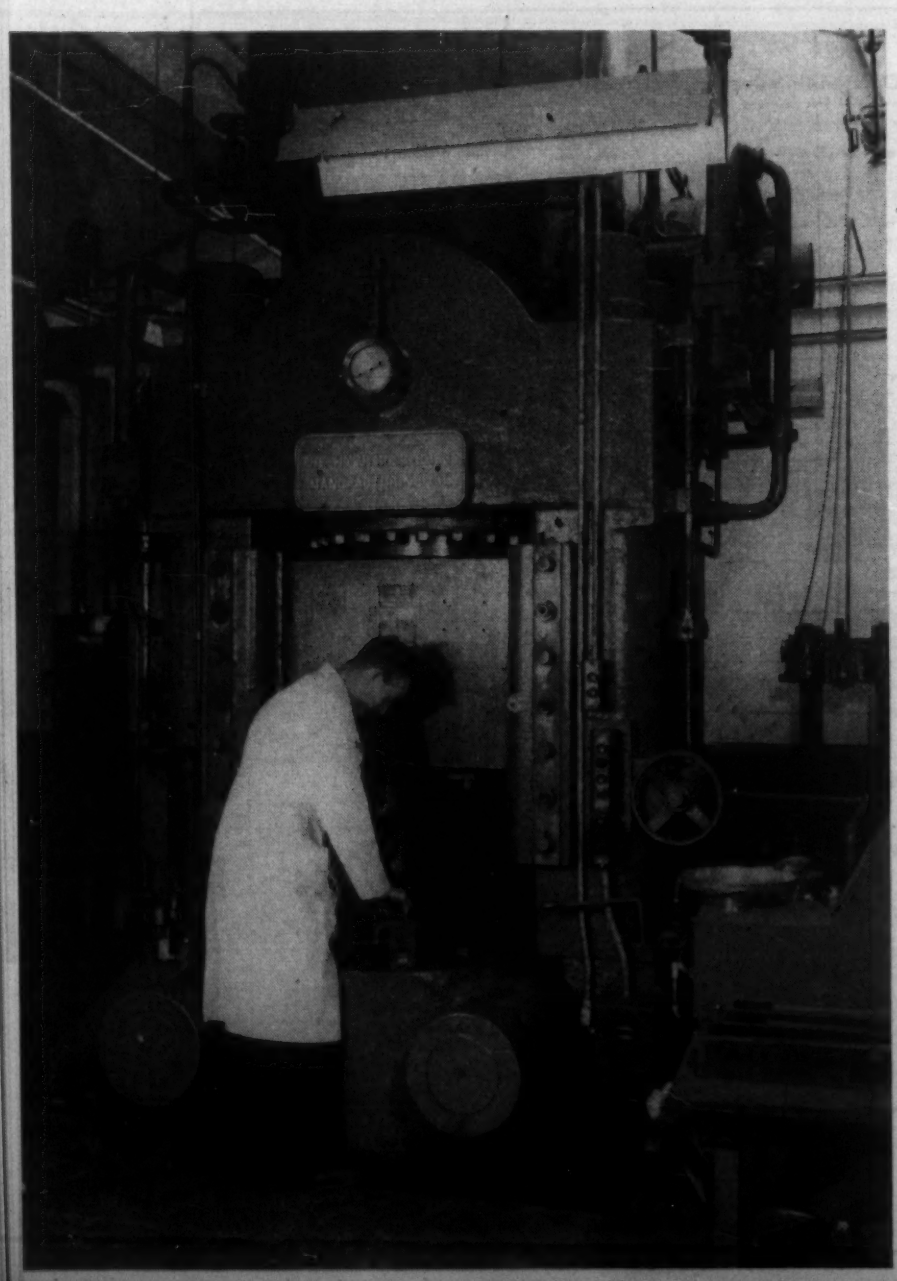
A great number of applications have been developed by A. C. Wickman (Canada) Ltd., who pioneered the manufacture of carbide tools in England. Cutting tools include not only the regular lathe tools, but also form tools, some with quite extensive and complicated forms such as reamers, which have long narrow slips of carbide only on the working surfaces. Micrometer anvils and the wearing surfaces of inspection gages lend themselves excellently to the use of this material, which maintains its size many times as long as the hardest of other materials.

A Powder Metallurgy Application

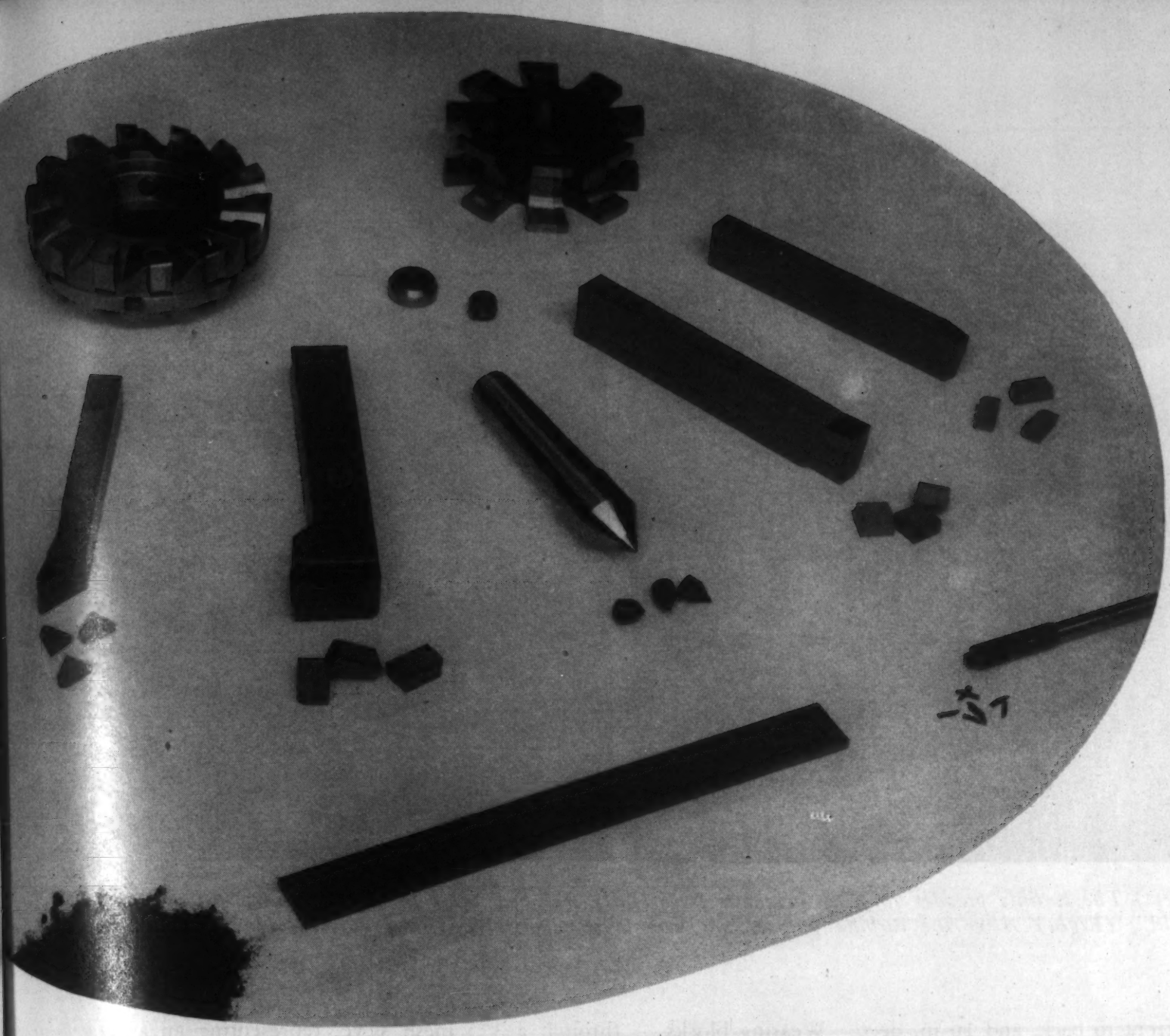
The actual production of the tips from powders of tantalum carbide, tungsten carbide and titanium carbide in various proportions, is a striking example of an application of powder metallurgy. Tungsten, the metal, was one of the earliest substances which was found to demand powder metallurgical treatment. When the value of the metal was realized as a filament in the incandescent lamp, it was found impossible to attain a temperature at which it could be melted and cast into bars for drawing to the fine diameter needed. However, tungsten powder could be compressed and sintered into bars at a reasonable temperature, and was then plastic enough for drawing. The same treatment is accorded to the carbides.

Although tungsten carbide was first produced nearly 50 yrs. ago, the discovery excited little interest for a number of years. The reason was that although the material was extremely hard and would scratch a sapphire, its strength was too low to enable it to be put to practical use.

However, nearly 20 yrs. ago, a method was discovered in Germany of increasing the strength of the



A 750-ton tungsten carbide briquetting press installed in the plant of A. C. Wickman (Canada) Ltd., New Toronto, Ontario, Canada. Press was designed and built by The Hydraulic Press Mfg. Co., Mount Gilead, Ohio.



Representative group of carbide tools manufactured by the author's company—reamer, lathe center, die, lathe tools and milling tools. The carbide powder, carbide briquette and individual tool tips are also illustrated.

carbide. This involved the addition of a small amount of "cementing metal," which during the sintering operation forms an alloy by partially dissolving the hard carbide particles, and on cooling, cements the hard particles into a fairly strong, hard, compact mass. The cementing metal usually used is cobalt, although nickel and iron may also be used.

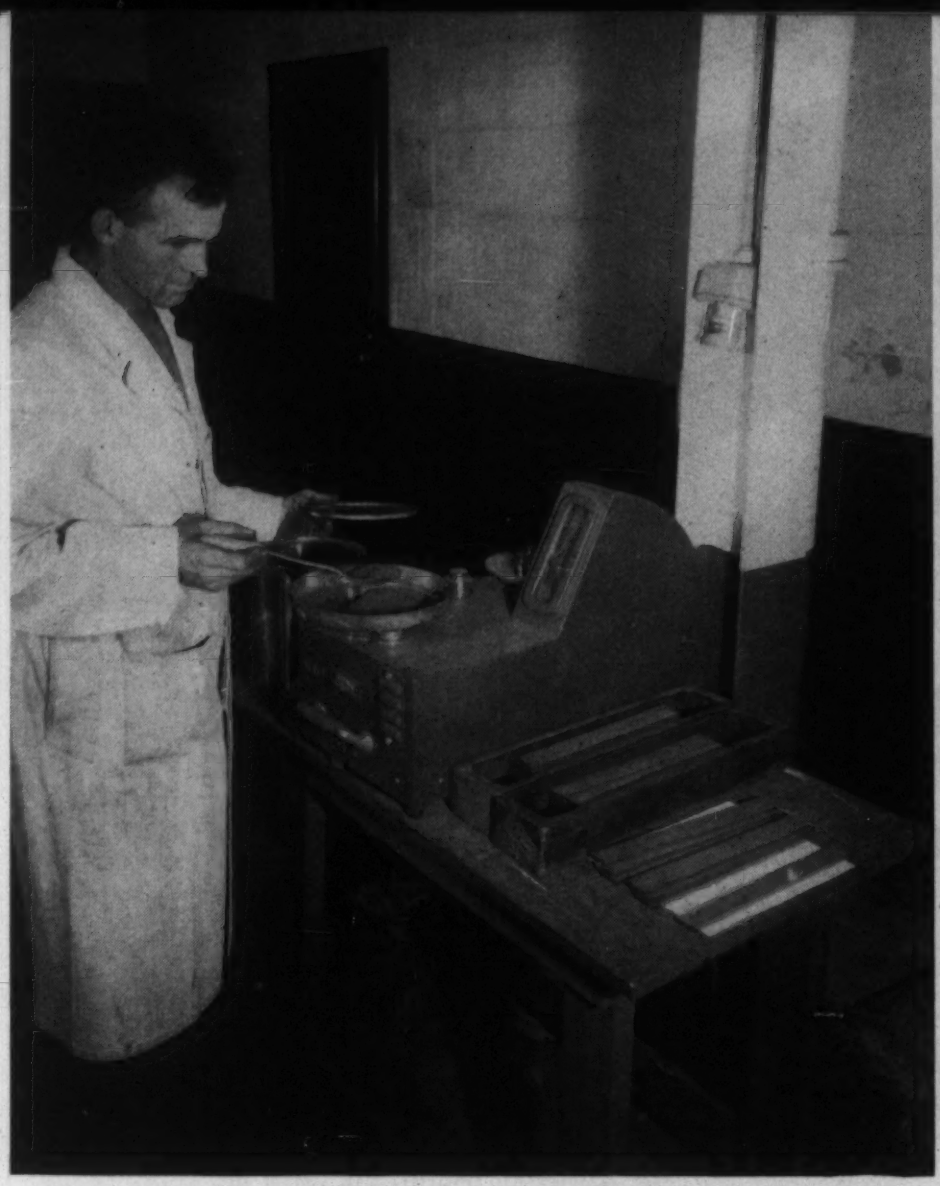
Tungsten carbide is the main constituent of most cemented hard alloys, but during recent years small amounts of other carbides, such as titanium and tantalum, have been added to impart special properties to the alloy for various purposes.

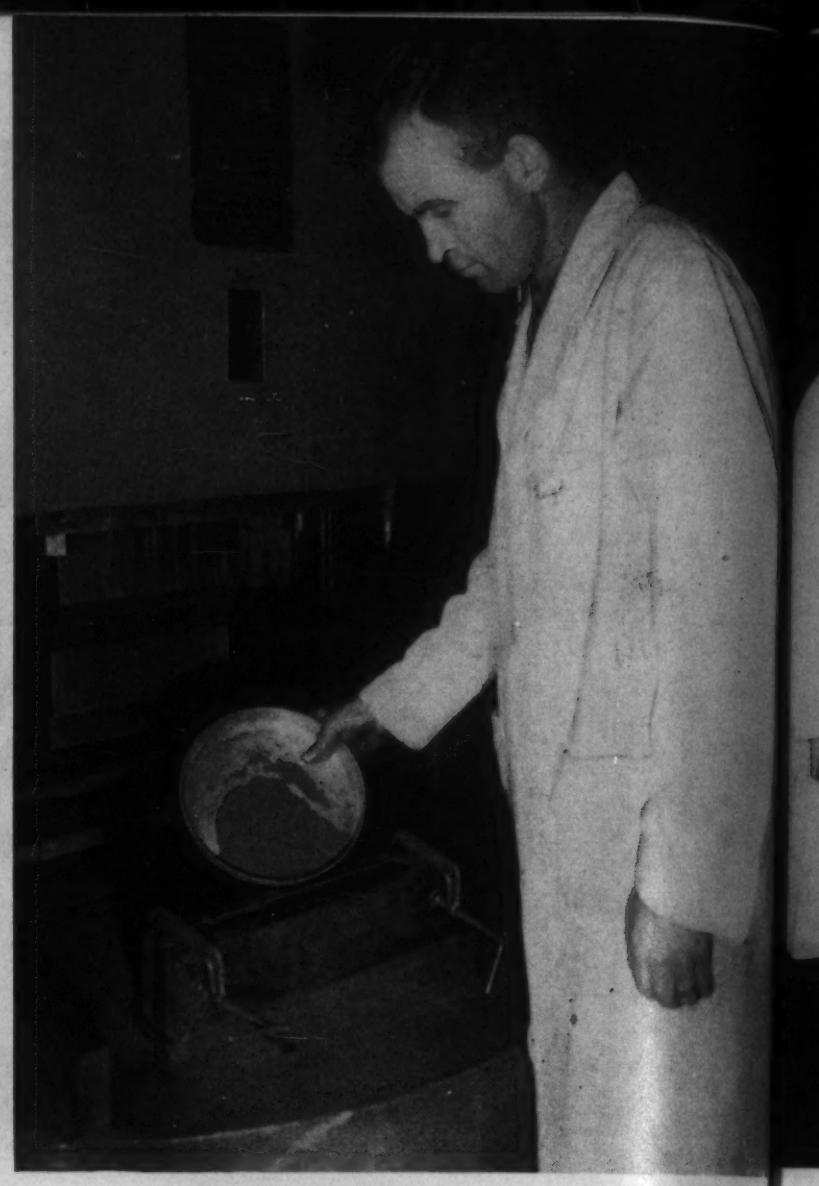
The Press Used

A specially designed "Fastraverse" hydraulic press (manufactured by The Hydraulic Press Mfg. Co., Mount Gilead, Ohio) is used to compress the powders prior to sintering and machining. A special feature of this press is that a hydraulic cylinder and ram assembly has been built into the press bed. Otherwise the press is of this company's standard design. The press frame consists of a head and a bed, spaced by a pair of uprights. Two pre-loaded tie rods passing through each upright lock the assembly together as one solid unit. The uprights are accurately aligned with head and bed by special patented circular keys.

The press head incorporates the hydraulic cylinder with a power ram which actuates the main slide. The main slide is gib guided. Pressure capacity of the downward acting press member is 750 tons. This pressure is adjustable so that the correct briquetting pressure can be secured for various blanks or briquettes to be made.

The platen of the horizontal acting ram forms the back side of a rectangular recessed opening in the press bed. The other three sides are stationary, each being an integral part of the press bed. With the horizontal clamp closed, the opening in the bed has the following dimensions: 24 in. left to right, 18.5





(Left) The carbide powder for each briquette is carefully weighed prior to placing the powder into the mold. (Right) After the carbide powder has been accurately weighed, it is poured into the mold.

in. front to back, and 16 in. deep. Wearing blocks are usually fastened to each side and to the horizontal clamp platen. Just below the opening in the bed is mounted a pneumatic ejector. This ejector is used to raise and lower the briquette mold. The horizontal mold clamp ram also has a pressure capacity of 750 tons.

Pressure for both the briquetting and clamping actions is supplied by a single radial piston type hydraulic pressure generator, with direct motor drive through flexible coupling. A 20-h.p. motor is employed, but due to the efficient design of the radial pump, maximum load is not required for the complete press cycle.

Molding and Pressing

The die is a box made up of steel slabs, which must be assembled and disassembled each time a briquette is made. The die is not fastened, the sides being suitably tenoned, splined and held together during the pressing operation by the horizontal mold clamp in the press bed.

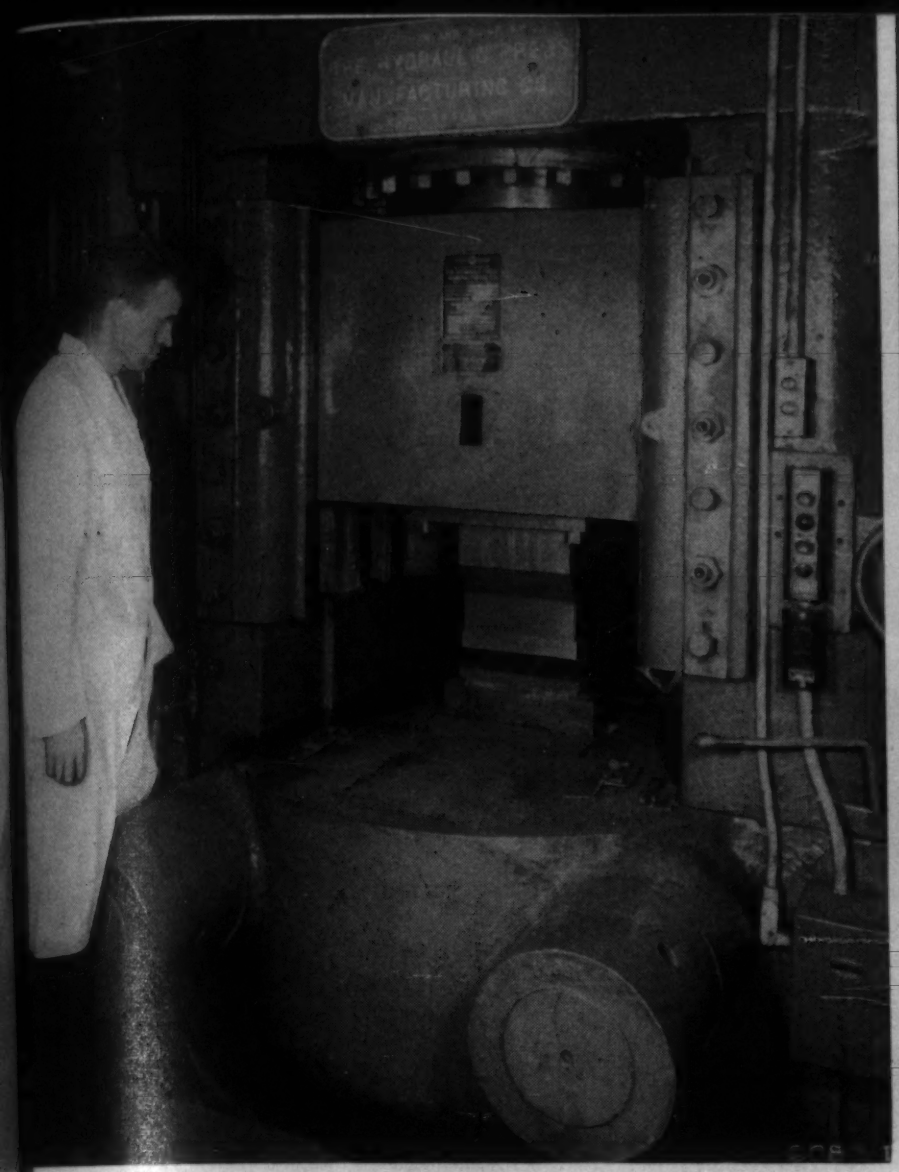
The four sides and the bottom of the mold are clamped together with two "C" clamps and a quantity of the carbide powder, the analysis of which is determined by the grade of tools required, is carefully weighed and poured into the mold and levelled off. The powder is extremely fine, having been screened through a 325 mesh sieve, representing an average grain size of about 0.00004 in. dia.

The punch is then positioned on top of the material and the loaded mold is then slid across the bed table over to the aperture. The ejector is raised to bed level and the mold is positioned on the pneumatic ejector platen. The "C" clamps are removed and the mold is lowered into the press bed by receding the ejector. The horizontal clamp ram is closed against the side of the mold, and the downward acting press slide closes rapidly against the mold punch.

A pressure of 60,000 lbs. per sq. in. (30 tons) on the material is required to briquette the powder. The main press slide is reversed automatically when this pre-determined pressure is obtained. As soon as the main press slide reaches its initial top position, the ejector raises the mold to the table surface for disassembly and removal of the blank or briquette.

Sintering

Measuring, in a typical case, about 12 in. in length, $1\frac{1}{8}$ in. in width by $\frac{1}{4}$ in. thick, the briquette must be handled with care and is unexpectedly heavy. Placed in graphite "boats" or trays which have been formed out of solid graphite blocks, the material is taken to the first sintering furnace—a continuous pusher furnace, electrically heated to 1100 deg. F. and containing an atmosphere of pure hydrogen, so that there is



(Left) The top of the mold is placed in position, and the mold is lowered into the opening in the press bed. A horizontal acting hydraulic ram clamps the mold during the briquetting operation. (Right) After the downward acting press ram has briquetted the powder, the mold is disassembled, and the tungsten briquette is removed.

The carbide tips are packed inside a graphite "boat" containing alundum powder. The "boat" is placed in a continuous pusher furnace which is electrically heated and which contains an atmosphere of pure hydrogen. Here the second and final sintering takes place.

The tungsten briquette is sintered and then formed to the shape of the tool tip. A diamond saw is sometimes used to cut the briquette into small nibs or tips.

no tendency for oxidation, which would ruin the material.

To maintain a positive pressure of hydrogen in the chamber, a minute leakage is maintained, burning quietly as it emerges. This is necessary with controlled atmosphere furnaces. The timing of the material through the furnace may be varied. The boat passes from the hot zone through a water jacketed cooling chamber, and the carbide material emerges ready to be worked, but it is not yet to final hardness.

At this stage the briquette is cut up into the required shapes. It can be cut with a diamond saw, turned in a lathe, ground, milled or drilled, depending upon final shape required. Shrinkage from the second sinter, which is to follow, is considerable and allowances must be made.

The carbide now goes through a second sintering furnace, where it is subjected to a temperature of 2,550 to 2,750 deg. F. in a hydrogen atmosphere. To ensure even heating, each piece is individually packed in alundum powder, to which the carbides are completely inert. Here it attains its full hardness and must thereafter be ground. Although looking like steel, the specific gravity of the material is nearly double that of steel. The extreme hardness quickly dulls even the hardest of abrasive grains, so that a soft-bonded wheel is necessary to ensure continuously sharp cutting edges for dressing a tool.

The improvements in methods of manufacture, including the development of presses like that described here, plus the increasingly wide acceptance of the carbide material, have, by successive steps, reduced the cost of the tips and other forms from $453 per lb. in 1926 to $80 per lb., and later to $48. A further decrease has been announced in both Canada and the United States.

The carbide tool business is only one of many industries in the powder metallurgy field. Metallurgists, mechanical engineers, and production executives are increasingly interested in the possibilities of powder metallurgy as a technique pointing toward faster production methods and the elimination of machining in the manufacture of parts.

METALS and ALLOYS
Engineering File Facts

NUMBER 37
February, 1944

PROCESSES AND PROCEDURES
Welding

The Control of Weld Hardening

Production men familiar with metal working know that certain steels have higher hardening tendencies than others in the heat-affected zone adjacent to a weld, and that such metals require somewhat different arc welding procedures to assure successful welding.

It should be understood that the tendency to weld-harden is not a function of the composition alone. The degree which a given steel will weld-harden is a function of the ratio of rate of heat input to rate of heat dissipation at the weld, which, in turn, determines the rate of cooling of the weld and thus the degree of hardening.

To reduce weld-hardening of a given steel, it is necessary to have:

(A) High rate of heat input to weld. This can be controlled to some extent by using high welding currents in relation to welding speed.

(B) Low rate of heat dissipation, which is a function of (1) mass of parent plate (thin plate gives low rate); (2) temperature of plate (the higher the preheat, the lower the rate of heat dissipation).

The above statement explains in a general way why, for example, a given steel may be welded in ¼-in. plate without preheating but must be preheated in 1-in. plate if excessive weld-hardening and a tendency for cracking are to be avoided.

Effect of Composition

Of the various common elements added to steel, carbon is by far the most potent in increasing its hardening capacity. Manganese, phosphorus, chromium, vanadium, molybdenum, silicon, copper, nickel and other alloys are often added to increase elastic properties and ultimate tensile strength. While many attempts have been made to classify the above alloying elements as to their relative effectiveness in increasing the hardening tendency of steel, there has been little general agreement on the subject. It is likely that certain combinations of alloying elements are more effective than single additions of equivalent total amounts.

It is said, however, that the maximum hardness obtainable by rapid cooling is determined largely by the carbon content of the steel. The addition of the usual amounts of alloys to a carbon steel does not increase its maximum hardness on rapid cooling but merely increases the sluggishness of the transformation, which results in full hardening at lower rates of cooling.

Preheating

Preheating is one of the most useful methods of slowing down the cooling rate of a weld, thus reducing weld-hardening. The following classification is intended as a guide in determining whether or not preheating may be desirable. These recommendations are necessarily of a general nature, and are intended to indicate what step may be necessary in order to produce joints substantially free from weld-hardening. It is recognized that for many applications satisfactory welds are being made in hardenable steels without preheating and are satisfactory under certain service conditions. The following guide is for use where the technique possible under specific conditions requires preheating, and does not mean that preheating should be used on work now being done successfully.

General Guide for Preheating

Straight carbon steel under 0.25% C	In general, preheating is not necessary, except with carbon contents on the high side of this range and with heavy plate and rigid joints. Preheat temperatures are 100-300° F.
Straight carbon steel 0.25-0.35 C (or) Low alloy steel 0.12-0.20 C	Preheating is desirable though usually not necessary in thin sections. Preheat temperatures are 200-400° F.
Straight carbon steel 0.35-0.45 C (or) Low alloy steel 0.20-0.30 C	Preheating is desirable and in most cases necessary. Preheat temperatures are 300-500° F.
Straight carbon steel above 0.45 C (or) Low alloy steel above 0.30 C (or) Alloy carbon-base steel above about 3% alloy	Preheating is necessary. Preheating temperatures are 400-600° F.

In addition to reducing weld hardening, and the consequent danger of cracking, preheating will help to reduce shrinkage stresses and the resulting distortion in the work. Even when preheating is not required by metallurgical factors, it may be desirable from one of these considerations. This is the case with large pieces or complicated shapes in mild steel, or with work being welded outdoors in winter weather.

Other Methods

Repair work sometimes makes necessary the welding of parts that have been finish-machined to close tolerances. Preheating, or stress relieving after welding, will usually not be possible. The usual procedure in such a case, to hold the finished dimensions of the piece and still exercise some control of weld hardness, is to weld slowly, laying in a bead and permitting the work to cool to room temperature. Often the welding heat is localized by surrounding the weld area with damp cloths, so preventing warpage and change of dimension through the mass of the work.

An after treatment of welded parts, either to reduce weld hardening or to relieve locked-up stresses due to welding, is advisable in weldments that are to be machined to close tolerances. No annealing of low-carbon steel pieces is necessary, but stress relieving is frequently desirable. Medium carbon steels may be given an after treatment at 1100 to 1200° F. to restore properties, while a post-heating treatment at 1200 to 1450° F. is advantageous with high-carbon steels.

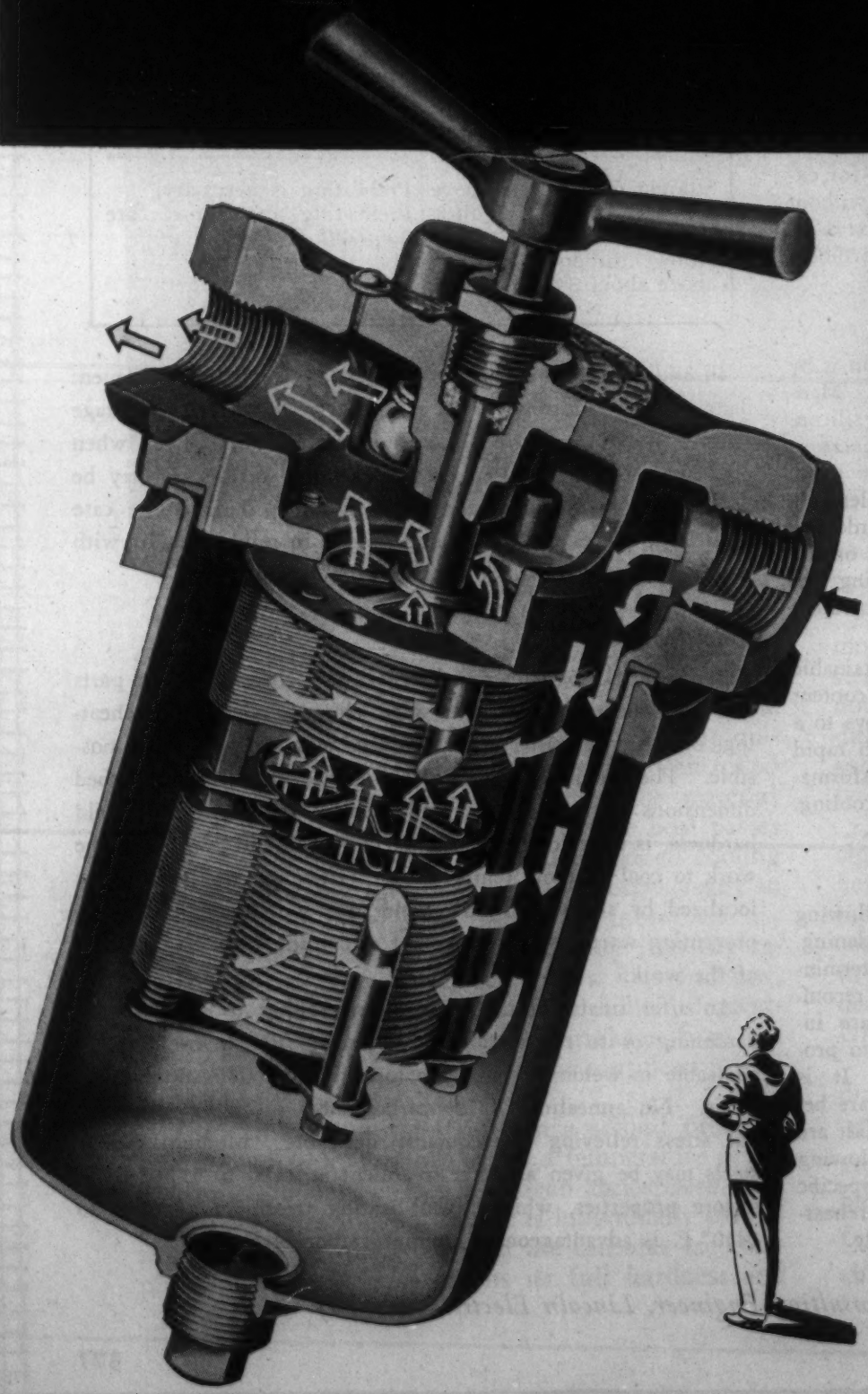
Prepared by W. J. Conley, Consulting Engineer, Lincoln Electric Company

Q. How can you provide for continuous filtration—without shutdowns for filter cleaning?

A. 1. A Cuno Auto-Klean full-flow filter,

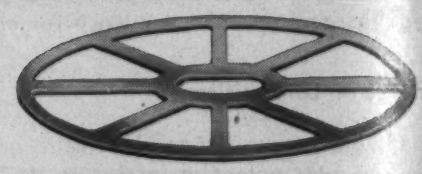
or

2. An expensive, space-consuming duplex installation requiring high maintenance cost.



The Inside Story

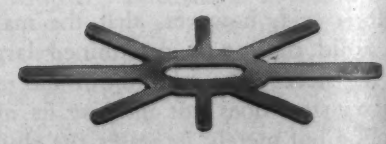
1



METAL DISCS DO THE FILTERING

The filter element consists of a stack of flat wheel-shaped discs, stamped from strip metal rolled especially to close tolerances for Cuno.

2



DEGREE OF FILTRATION DECIDED HERE

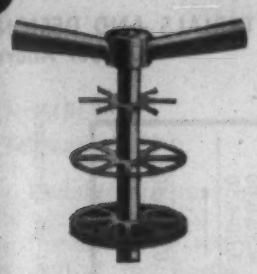
Each disc is separated from the next by a thin metal spacer. The thickness of the spacer determines the degree of filtration.

KEEP FLOW ON "GO" WITH

CUNO

THE "FILTER-FINE" STRAINER

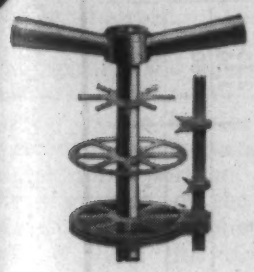
3



THE SHAFT IS ROTATABLE

Discs and spacers are mounted in a fixed position on a central rotatable shaft. The "spokes" of these parts are positively aligned so that the open areas between them form channels lengthwise within the cartridge.

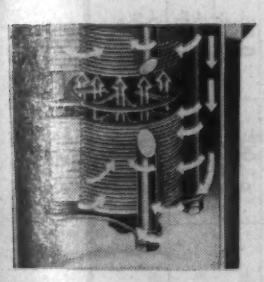
4



FILTER CLEANED BY METAL BLADES

On a stationary rod paralleling the rotatable stack of discs are mounted knife-like cleaner blades. These blades, slightly thinner than the spacers, extend into the slots between discs as far as the inside edge of disc rims.

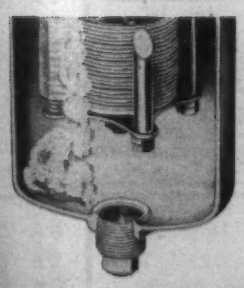
5



EDGE FILTRATION STOPS SOLIDS

Fluid from filter inlet surrounds cartridge and is forced by differential pressure to flow radially inward through slots between discs. Solids larger than slot opening are retained. Filtered fluid flows up through central channels to filter outlet.

6



SOLIDS ARE COMBED OUT

When the cartridge is rotated (manually or automatically) past stationary cleaner blades, all accumulated solids are combed from slots and settle to the bottom of the sump. This does not interfere with fluid flow.

QUICK FACTS ON FLUID CLEANING

Send coupon for information relative to your fluid-handling problem. Check off applications (or add any other below) which interest you.

CUNO ENGINEERING CORPORATION
452 South Vine Street, Meriden, Conn.

Please send me a free copy of QUICK FACTS. I am especially interested in the services checked.

- ☐ Acids
- ☐ Air
- ☐ Alkali
- ☐ Boiler Feed
- ☐ Casein
- ☐ Cleaning Solutions
- ☐ Coatings
- ☐ Compressed Air
- ☐ Coolants
- ☐ Cutting Oils
- ☐ Dip Tank Systems
- ☐ Enamel
- ☐ Engine Fuel
- ☐ Engine Lubricating Oil
- ☐ Fuel Oil
- ☐ Fuel Tar
- ☐ Gases
- ☐ Gasoline
- ☐ Grease
- ☐ Grinder Coolant
- ☐ Hydraulic Oil
- ☐ Japan
- ☐ Lacquer
- ☐ Lubricating Oil
- ☐ Machine Tool Cutting Oil
- ☐ Machine Tool Hydraulic Oil
- ☐ Machine Tool Lubricating Oil
- ☐ Nitrocellulose Solutions
- ☐ Oils
- ☐ Paint
- ☐ Pyroxylin
- ☐ Quenching Oil
- ☐ Resins
- ☐ Rust Proofing Compounds
- ☐ Sizing
- ☐ Solvents
- ☐ Spray Systems
- ☐ Tar
- ☐ Test Stand Lubricating Oil
- ☐ Varnish
- ☐ Washing Compounds
- ☐ Water
- ☐ Wax

Name .....

Company .....

Address .....

CUNO ENGINEERING CORPORATION
452 South Vine Street, Meriden, Conn.

Please send me a free copy of QUICK FACTS. I am especially interested in the services checked.

- ☐ Acids
- ☐ Adhesives
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- ☐ Alkali
- ☐ Ammonia
- ☐ Animal Oils
- ☐ Asphalt
- ☐ Banana Pulp
- ☐ Beer
- ☐ Beverages
- ☐ Casein
- ☐ Castor Oil
- ☐ Caustic
- ☐ Cellulose
- ☐ Cement
- ☐ Chocolate
- ☐ Coatings
- ☐ Coolants
- ☐ Dope
- ☐ Enamels
- ☐ Extracts
- ☐ Flavors
- ☐ Fuel Oil
- ☐ Gases
- ☐ Gasoline
- ☐ Glue
- ☐ Grease
- ☐ Gum
- ☐ Hydrogenated Oil
- ☐ Ink
- ☐ Lacquers
- ☐ Latex
- ☐ Molasses
- ☐ Paint
- ☐ Palm Oil
- ☐ Paraffine
- ☐ Paste
- ☐ Pyroxylin
- ☐ Resins
- ☐ Rubber Cements
- ☐ Sizing
- ☐ Soap
- ☐ Solvents
- ☐ Syrups
- ☐ Tar
- ☐ Tooth Paste
- ☐ Vegetable Oils
- ☐ Water
- ☐ Wax

NAME .....

COMPANY .....

ADDRESS .....

Red and Yellow Brasses

A Digest of Common Specifications

Compiled by Robert S. Burpo, Jr.

Name	Characteristics	Specification	Form	Composition, per cent						
				Cu	Sn	Pb	Zn	Fe (max.)	Ni (max.)	Others
Red Brass, Ounce Metal No. 1 Composition Leaded Red Brass, (85-5-5-5)	Combines fair strength and machinability with good casting and non-corrosive qualities widely used for fittings, valves, etc. (where max. temp. is 406°F.)	SAE 40	Sand Castings	84.00-86.00	4.00-6.00	4.00-6.00	4.00-6.00	0.25	0.75	P 0.05 Max.
		ASTM B30, Alloy No. 4A	In Ingot Form for Sand Castings	84.00-85.50	4.50-5.50	4.50-5.50	4.50-5.50	0.25	0.50	P 0.01 "
		ASTM B145, Alloy No. 4A	Sand Castings	84.00-86.00	4.25-4.75	4.50-6.00	4.00-6.00	0.30	1.00	P 0.03 "
Commercial Red Brass, or Leaded Red Brass (83-4-6-7)	Higher lead content improves machinability; used for parts where max. pressure is 40-50 psi and max. temp. is 250°F.	ASTM B30, Alloy No. 4B	In Ingot Form for Sand Castings	82.00-83.50	3.50-4.25	5.75-6.75	6.00-7.50	0.25	0.50	P 0.01 "
		ASTM B145, Alloy No. 4B	Sand Castings	82.00-83.75	3.25-4.25	5.50-7.00	5.50-8.00	0.30	1.00	P 0.03 "
Leaded Semi-Red Brass (80-3-7-9) and 76-3-6-15	Machinability better than that of above alloys, with corrosion resistance about the same as that of 85-5-5-5 alloy.	ASTM B30, Alloy No. 5A	In Ingot Form for Sand Castings	78.00-82.00	2.75-3.25	6.00-8.00	7.00-10.00	0.35	0.50	P 0.01 "
		ASTM B145, Alloy No. 5A	Sand Castings	78.00-82.00	2.50-3.25	6.00-8.00	7.00-10.00	0.40	1.00	P 0.02 "
		ASTM B30, Alloy No. 5B	In Ingot Form for Sand Castings	75.00-76.75	2.75-3.25	5.50-6.50	14.00-16.00	0.35	0.50	P 0.01 "
		ASTM B145, Alloy No. 5B	Sand Castings	75.00-76.75	2.50-3.25	5.25-6.25	13.00-17.00	0.40	1.00	P 0.02 "
High Strength Brass	Has excellent hot working properties.	ASTM B124[2], Alloy No. 11	Forging Rods, Bars and Shapes	78.00-93.00	.060 Max.	—	(Si 2.25 Max.)[1]	4.00	5.50[1]	Al 6.50-11.00 Mn 2.00 Max.
High Strength Yellow Brass or Manganese Bronze	These alloys have high strength and anti-corrosion properties—have poor cold-working qualities. The cast alloys are strong, ductile, non-magnetic and resistant to corrosion; used for parts for marine and hydraulic machinery, gears, worm wheels, etc.	ASTM B124[2], Alloy No. 6	Forging Rods, Bars and Shapes	63-68	0.50 Max.	0.20 Max.	Rem.	2.0-4.0	—	Al 3.0-6.0 Mn 2.5-5.0
		ASTM B138, Type B	Rods, Bars and Shapes	63.00-68.00	0.50 Max.	0.20 Max.	"	2.00-4.00	—	Al 3.00-6.00 Mn 2.50-5.00
		ASTM B147, Alloy No. 8B	Sand Castings	61.00-63.50	0.25 Max.	0.10 Max.	"	2.50-3.50	1.00	Al 4.50-6.00 Mn 3.00-4.50
		ASTM B132, Class B	Sand Castings	58.0 - 64.0	1.50 Max.	0.50-1.50	"	3.00	—	Al 3.00 Max. Mn 3.50 "
		ASTM B132, Class A	Sand Castings	55.0 - 60.0	1.50 Max.	0.50-1.50	"	2.00	—	Al 1.50 " Mn 1.50 "
		SAE 43	Sand Castings	55.00-60.00	1.50 Max.	0.40 Max.	38.00-42.00	2.00	—	Al 1.50 " Mn 3.50 "
		ASTM B138, Type A	Rods, Bars and Shapes	57.00-60.00	0.50-1.50	0.20 Max.	Rem.	0.80-2.00	—	Al 0.25 " Mn 0.50 "
	Emergency alternate alloy.	ASTM B124[3], Alloy No. 4	Forging Rods, Bars and Shapes	57.0 - 60.0	0.5 - 1.5	0.20 Max.	"	0.8 - 2.0	—	Al 0.25 " Mn 0.50 "
		ASTM B124[3], Alloy No. 5	Forging Rods, Bars and Shapes	57.0 - 61.0	0.5 - 1.5	1.00 Max.	"	0.8 - 2.25	—	Al 0.75 "
		ASTM B147, Alloy No. 7A	Sand Castings	56.00-62.00	1.50 Max.	0.50-1.50	"	2.00	—	Al 1.50 " Mn 1.50 "
		ASTM B147, Alloy No. 8A	Sand Castings	56.00-59.00	0.50 Max.	0.40 Max.	"	0.75-1.50	0.50	Al 0.75-1.50
		ASTM B30, Alloy No. 7A	In Ingot Form for Sand Castings	56.00-62.00	0.50-1.00	0.50-1.00	"	0.75-1.50	0.50	Al 0.25-1.00 Mn 0.10-0.50
		ASTM B30, Alloy No. 8A	Sand Castings	56.00-59.00	0.50 Max.	0.25 Max.	"	0.75-1.50	0.50	Al 0.75-1.50 Mn 0.10-0.50
		ASTM B30, Alloy No. 8B	Sand Castings	61.00-63.50	0.25 Max.	0.05 Max.	"	2.50-3.50	1.00	Al 4.50-6.00 Mn 3.00-4.50
		ASTM EA-B30, Alloy No. 6X	Sand Castings	66.00-74.00	0-1.50[3]	2.00-4.00	"	0.60	1.00[3]	—
		ASTM EA-B30, Alloy No. 6Y	Sand Castings	66.00-74.00	0-1.50[3]	2.00-4.00	" "	0.60	1.00[3]	Al 0.20-0.50

[1] When both Si and Ni are present, only one shall be in excess of 0.25 per cent.
[2] Emergency alternate alloys EA-B124 may be used in place of the B124 alloys; the compositions of the alternate alloys are the same as those of ASTM B124 except that an alternate grade of copper (ES-7) is used
[3] Sn and Ni shall not be added intentionally

METALS and ALLOYS
Engineering File Facts

Radiography of Metals

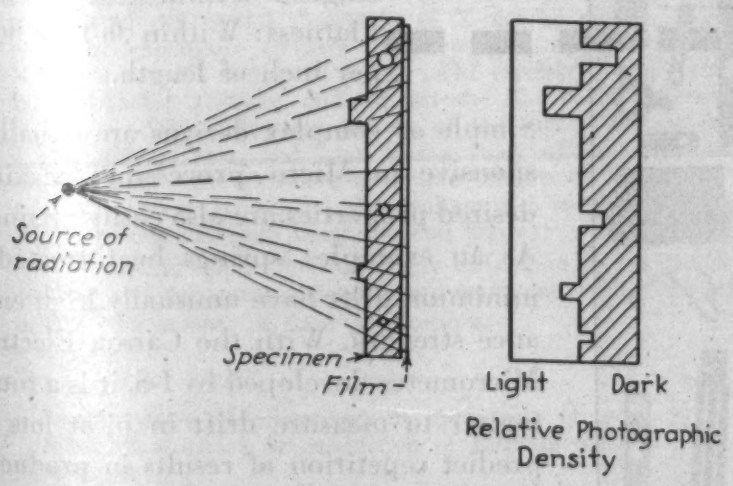
A Summary of its Application

NUMBER 39
February, 1944

PROCESSES AND PROCEDURES
Radiography

Radiography may be defined as the non-destructive inspection of matter with X- or gamma-rays. It is applied in the metal industries as a routine inspection tool and as a research or analytical instrument. As an inspection tool, radiography is employed to pass on the soundness of metal parts and weldments; as an analytical instrument, it is used in diffraction and microradiography to study the structure and structural details in metals.

X- and gamma-rays are a form of radiant energy that have the ability to penetrate through matter without being completely absorbed. The amount of the radiation allowed to pass through a material without being absorbed depends upon the density and atomic number of that material and its thickness. If cavities or inclusions of a lesser density are present in the interior of a specimen of metal, the beam of radiation has less metal to pass through at those points than in the solid portion. Consequently, there is a variation in the absorption of the rays at these points. Since X- and gamma-rays effect photographic emulsions in much the same way as light, this difference in absorption of rays or difference of density can be recorded or a photographic film placed behind the specimen. Thus, an X-ray image of the specimen is produced with variations of photographic density corresponding to the density differences from point to point in the specimen. This, essentially, is the basis of the radiographic procedure, and is shown schematically in the accompanying figure.



The X-ray Method

X-rays are produced when a rapidly moving stream of negatively charged particles (electrons) are suddenly stopped by matter. This is accomplished by means of an X-ray generating apparatus, which essentially includes (1) a source of electrons, (2) a target located in the path of the electrons, and (3) a means of applying a potential difference between the cathode and the target, in order to give the electrons the required speed before hitting the target.

The X-ray method is the one most widely used in applications of radiography to the examination of metals. It is used in diffraction analysis, microradiography, and routine radiographic inspection.

Instead of impinging upon a photographic screen, the rays may be directed upon a fluorescent screen, where a shadow picture similar to the exograph, but non-permanent, is produced. This is called fluoroscopy. Its sensitivity is low (about 10%), and its applications are limited to the light metals or thin sections of the denser metals. There is no permanent record of the shadowgraph. However, because it is quick and cheap, saving the cost of film, chemicals and photographic equipment, it is being used to detect gross defects in metal parts within its working range.

The Gamma-ray Method

Gamma-rays are produced from the disintegration of radioactive elements. The gamma-ray procedure of radiography consists of placing a pellet of radium at a predetermined distance from the object to be radiographed. The photographic film is placed on the side of the object away from the pellet, thus exposing the film to the radiation that passes through the object. Radium salts, such as radium chloride or radium sulphate, are generally used as the source of gamma-rays in industrial radiography.

The use of the gamma ray method is limited to the inspection of metals for gross internal defects and is not practical for diffraction analysis or microradiography. In the radiographic inspection of steel it is possible to examine sections up to 10 in. thick with satisfactory results.

Comparison of the X-ray and Gamma-ray Methods

Gamma-rays are limited to radiographic inspection of metals for detection of gross defects, while the X-ray method is used in all three applications of radiography to metals examination. Thus, X-rays and gamma-rays, if they may be said to compete, do so only in the one application, that is, in the radiographic inspection of metals.

Both methods have their own particular limitations and advantages. X-ray apparatus (except for one million volt units) is limited to the examination of steel under around 5 or 6 in., while gamma-ray inspection is possible up to 10 in. The chief disadvantage of the gamma-ray method is the exposure time required, which runs into hours or days. So, it would seem that radiography, with radium, supplements that with X-rays, in that it is used chiefly in thicknesses that cannot be penetrated by X-rays. Below are listed the advantages of each method:

Advantages of Gamma Ray

1. High latitude of density gradations on irregular parts.
2. Less scattering than X-rays.
3. Low cost per unit examination for low volume radiography.
4. Independent of mechanical breakdowns and maintenance.
5. Simplicity of operation.
6. Can be used in assemblies and parts inaccessible to X-ray apparatus.
7. Availability without high first cost.
8. Examination of steel thicknesses up to 9 or 10 in.

Advantages of X-ray

1. More sensitive up to 2 in. thicknesses of steel.
2. Short exposure times.
3. Good contrast and definition.
4. Interpretation of radiographs easier because of better contrast.
5. Wave length can be regulated for contrast or variable thickness.
6. Preferable for thin steel, light alloys and welds.
7. Greater flexibility than gamma-ray method.
8. Good control of exposure technique.

The applications of radiography in the metal industries may be generally classified under three heads: (1) radiographic inspection, (2) diffraction analysis, and (3) microradiography.

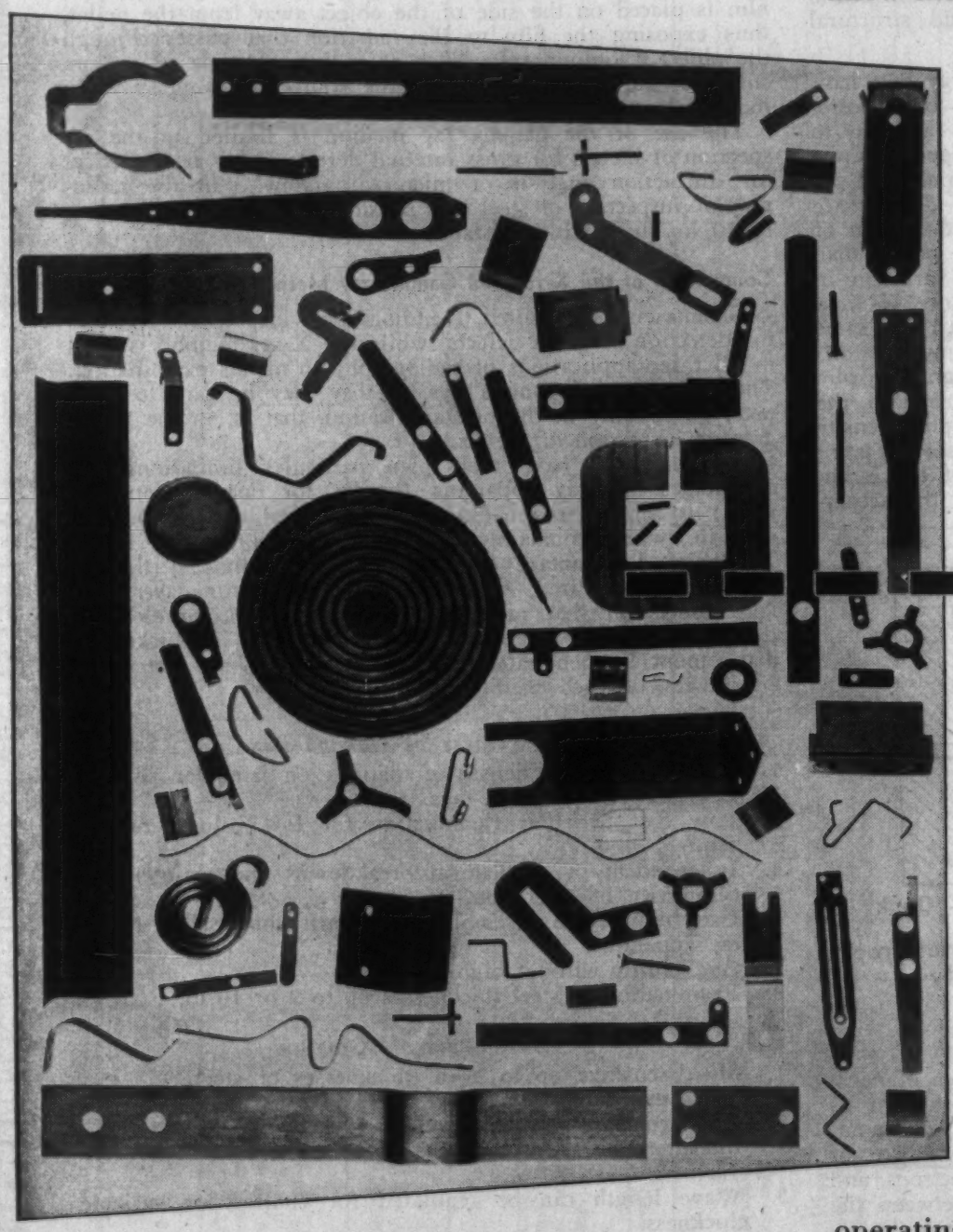
Radiographic Inspection

The purpose of inspection of metals by X-rays or gamma-rays is to examine the internal soundness and the homogeneity of fabricated parts. The principles involved in obtaining a radiograph have been explained previously.

The applications of radiography for the detection of defects in metal parts are many:

(Continued on page 385)

"Micro-Processed" Beryllium Copper
FLAT SPRINGS
Hold Proper Shape Indefinitely!



Micro-processing starts with the premise that if you know the characteristics of the beryllium copper strip you are using, know the physical and electrical requirements of the finished spring . . . then the variables of time-temperature involved in heat treat forming can be controlled within the closest of limits.

Flat springs with exceptionally long service life and original accuracy are the inevitable result.

Thus, Instrument Specialties delivers in any desired quantity (from one spring to millions) flat springs Micro-processed to the following tolerances:

Angles: Within ± 1° on bends.
Flatness: Within .001 to .003 in. per inch of length.

Simple or complex designs are equally responsive to Micro-processing; maximum desired properties are also easily attainable. As an example: springs heat treated for minimum drift have unusually high endurance strength. With the Carson Electronic Micrometer developed by I-S, it is a routine matter to measure drift in pilot lots and predict repetition of results in production quantities.

Great savings are possible by incorporating Micro-processed Beryllium copper flat springs in your equipment . . . assembly and maintenance cost is lowered, higher operating efficiency is obtained, and absolute uniformity of characteristics is assured.

Make use of our sample spring and engineering design departments — send drawings, samples, or specifications. We stand ready to prove our statement — on your own springs.

"Making Beryllium Copper Behave"
The story behind the development of micro-processing.

"Spiking A Rumor"
The facts about the greatly increased supply of beryllium copper.

"Predicting Spring Performance of Beryllium Copper Wire & Strip"
Why beryllium copper varies in hardening response and what to do about it.

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Metal castings—As a non-destructive test, radiography has found wide use in the casting industries. It is chiefly employed in the derivation of proper foundry technique and changes in the design of core and mold or in the process of gating. In addition, it is used widely as a required inspection method to pass on the soundness of production castings. The automotive and aircraft industries use radiography extensively for the inspection of parts.

Welds—As in castings, radiographic inspection is employed as an inspection tool as well as an aid in the development of good techniques and procedures. With it the smallest defects, such as cracks, incomplete fusion, slag and porosity in welds, can be detected.

Rolled and Drawn Metal—Radiography is used frequently on rolled sheet steel to detect any occurrence of slag inclusions. Effects of extreme cold drawing also can be detected, for example, in aluminum rod.

Miscellaneous applications—Inspection of: Insulated wires and cables and coated metals, for breaks; metal tubes, for clogging; assembled objects, for proper adjustment of parts; molten metals inside furnaces, for melting point and surface tension; ball bearings, for soundness; metal radio transmission tubes; metal sheets suspected of corrosion.

Diffraction Analysis

Study of the fine structural details of metals may be accomplished by X-ray diffraction. It is the one application of radiography where the method does not depend upon the principle of differential absorption of X-rays by matter. The procedure essentially consists of directing a small beam of X-rays at a small sample of metal. The crystals in the metal act as suitable gratings, and diffract the X-rays in different directions. The diffraction pattern of the rays is caught on a photographic film, and from this a study of the structure can be made. The exposure technique consists of high milliamperage (20 to 1000 MA), low voltage (25 to 60 KV) and relatively long exposure times (several hours).

The practical applications of X-ray diffraction in the metalworking and producing industries are many and varied. Listed below are a number of these applications:

Production of Metals

Determination of uniformity in production of steel.
Study of structure in production of forming metals.

Heat Treatment of Metals

Study of the effects of recrystallization of cold worked metals.
Detection of internal strains caused by heat treatment.
Effect of carbon content on annealing.
Relation between reduction, temperature of annealing and structure.
Determination of grain size.

Working and Fabrication of Metals

Study of directional properties in rolled and drawn steel.
Comparison of effects of twisting and bending steel wire.
Study of structure of welds.

Properties and Applications of Metals

Study of fatigue properties of metals.
Study of magnetic properties in steel.
Study of internal stresses or applied stresses.

Microradiography

Microradiography is a method for studying the gross structure of metals. Its results supplement those of photomicrography in that the microradiograph gives the actual structure through a layer of finite thickness rather than merely a polished surface.

The microradiographic procedure consists of taking a thin section (about 0.005 in. thick) of the metal under examination, and placing it between and in contact with a photographic film and a lead-foil screen with a hole about 1 millimeter in diameter for defining the X-ray beam that passes through the specimen. The resulting small black dot on the film is magnified several hundred times under a microscope.

In microradiography, differential absorption is essential for successful interpretation of the specimen and, therefore, careful consideration must be given in selecting the proper thickness of the specimen and the voltage in the X-ray tube. The operating voltage range is between 4000 and 8000 volts, and the current up to 50 milliamperes. The exposure times are relatively short compared to those used in diffraction work, and can be less than one minute in length.

The applications of microradiography are the same as those for photomicrography, and include the detection of nonhomogeneity and segregations, the study of structural details in metals and alloys, detection of hair-line cracks, and determination of proper heat treatment.

Voltage and Thickness Ranges for Applications of Radiography to Various Metals

Voltage Range Kilovolts	General Application	Magnesium Alloys	Aluminum Alloys	Steel	Copper Alloys
4-8	Microradiography				
25-60	Diffraction				
85-90	X-ray inspection	Up to 3 in.	Up to 2 in.	Up to ½ in.	Up to 2/5 in.
30-150	X-ray inspection	Up to 6½ in.	Up to 4½ in.	Up to 1½ in.	Up to 1 1/5 in.
60-250	X-ray inspection	Above 6½ in	Above 4½ in.	Up to 2½ in.	Up to 2 in.
120-400	X-ray inspection			Up to 5¼ in.	Up to 4¾ in.
600-800	X-ray inspection			Up to 7 in.	Up to 5 in.
1000	X-ray inspection			Up to 9 in.	Up to 7 in.

Prepared by H. R. Clauser

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Cleveland, Ohio.....Williams & Co., Inc.
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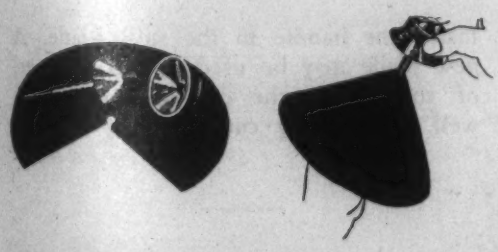
METALLURGICAL ENGINEERING shop notes

Lightening Hole Deburrer

by Russ Mannette and Walter Trezise,
Behr-Manning Div., Norton Co.

To keep aircraft light, holes, ranging from 2 to 7 in. in diam., are generally cut or stamped in the Dural stringers and bulkheads. However, the router



or stamping machine leaves burrs along the edges of the holes, most methods of removing which appeared unsatisfactory.

However, an ingenious cone made of Metalite cloth was devised and attached to the shaft of a motor and rotated at 1800 r.p.m. The hole is placed over the rotating cone, which easily removes the burr and gives to the edge on each side a slight radius.

The cone is designed for a 45° angle, found by experience to be the correct one, just as experience has dictated a speed of 1800 r.p.m. (In excess of 2000 r.p.m. the cone flares to a degree that makes it impractical.)

The motor may be attached to the bench with the shaft at right angles to the front edge so the cone will overhang. Optional mountings on drill presses, etc. are possible. A standard 3-jaw chuck or a special adapter would be required to hold the cone adapter if used with a bench mounted motor. To use on heavier gage Duralumin the No. 80 grit cloth is advisable; with lighter stock, the No. 120.

As the diameter of the Metalite cloth varies from 2 in. at the top to 8 in. at the base, practically any size lightening hole from 2 to 7 in. can be deburred. In shaping up the abrasive cloth cone, a ½-in. overlap is arranged and the cone fastened by an ordinary paper stapler.

By forging rear axle differential pinions instead of machining them from bar stock, Timken-Detroit Axle Co. expects to save 1,500,000 lbs. of high-grade steel by the end of the year. Formerly, the two sizes from bar stock were 4.77 and 1.65 lbs., but after machining were 1.34 and 0.50 lbs., the difference being waste. Now they are forged from pieces weighing 2.12 and 0.92 lbs., a saving of almost 50 per cent over the former practice. Moreover, the pinions made by forgings need only three major machining operations to finish them. The teeth require no machining. The pinions are from SAE 2612 or 9420 Grainal treated steel. They are carburized and hardened the same as any other gear, with 50,000-60,000 case, quenched direct.

—"Drop Forging Topics"
Drop Forging Assn.

Two Dissimilar Stampings from Same Die

by W. E. Edwards,
General Electric Co.

A big stamping and a little one from the same die is no optical illusion. A die stamps the same size, of course, but by passing the one at the right through a hydrogen furnace 200 times instead of once, the sample shrinks considerably.

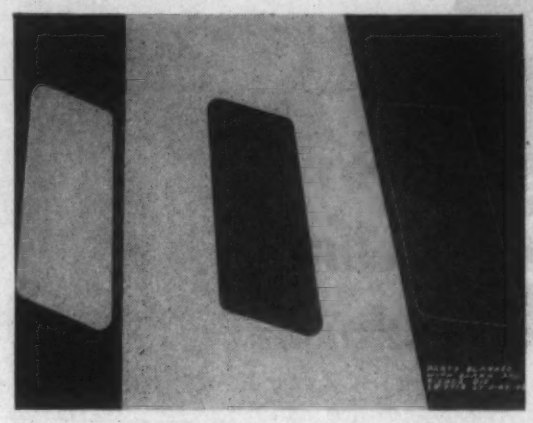
This shrinking has a practical application. By checking on the shrinkage of certain steel samples passing through electrically heated hydrogen furnaces, metallurgists can learn what effects to expect in heat-treating processes. The stampings lose no weight during the frequent treatments.

In the accompanying photograph the author holds the non-shrunk and shrunk stampings.

Band Saw Blades in Dies

by Arthur C. Vaughn & Lowell E. Hall, Curtiss-Wright Corp.

The conventional method of fabricating aircraft door openings in the aluminum skin is by "routing," which required



the additional operations of hand filing of the door for proper clearance, burring the edges, and drilling the holes.

Our newer method consists of making blank and pierce dies with worn out band saw blades, from which the teeth have been ground off. This new method has several main advantages: Doors are interchangeable; fit and clearance are perfect; five operations (two routing, two burring, and one drilling) are eliminated; there is a large saving in scrap. (The only scrap now is a 1/32-in. ring blanked out between the door and skin.)

The male die includes band saw blades, minus the teeth, as cutting edges and hole punches. The female die has a band saw blade kicker or scrap ejector. The 1/32-in. scrap ring is the exact clearance desired between the skin and the door in the assembly.

The die also punches the necessary screw holes in the door skin simultaneously. In the male die, additional punches form the ring of holes in the skin surrounding the door cut-out.

The skin is located on the die by an alignment bar attached to the female die and by two guide pins that pick up two designated holes in the skin, which makes use of the die fool-proof.

A blade can be replaced in about 1 hr., including grinding-off of teeth. Blades can blank 24 ST aluminum alloy up to 0.040 in. thick, and are good for cutting 5000 parts before replacement. The die is less expensive than the conventional one, because blade cutting edges do not require heat treating and forming. Blades are practical for all shapes within the bonding radius of the saw blade, which is about 1/8 in. Angles can be cut by breaking and butting the blades.

The upper photograph shows at the extreme left the aircraft door, blanked out from the space in the center, with the 1/32 in. band of scrap at the extreme right. Note the holes that have been punched both in the door and the skin surrounding the opening. In the bottom photo appear the blank and pierce die with the band saw blades in place, the female die at the left, the male at the right.

[The authors, connected with the Columbus branch of Curtiss-Wright, contributed these ideas through the Employee Suggestion System.—Editor]

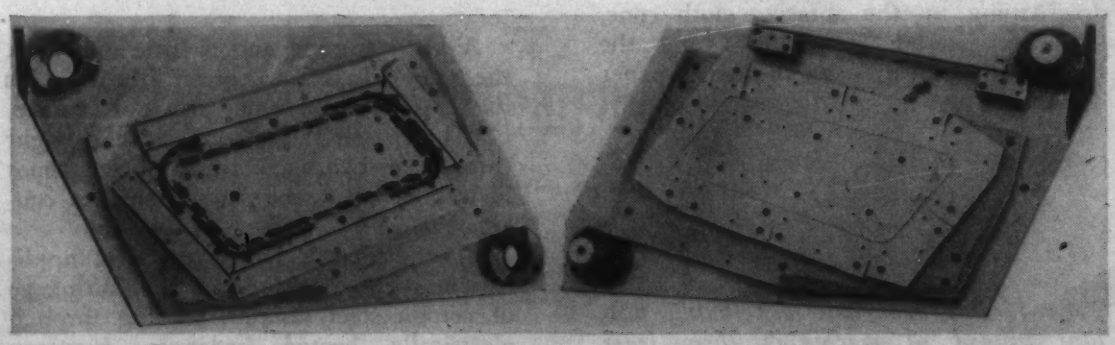
Avoiding Warpage in Welding

by O. T. Barnett, Metal and Thermit Corp.

Warpage of steel plates in welding is another case where an ounce of prevention is worth a pound of cure. Warpage is prevented commonly by proper procedures, such as skip and skip-step-back techniques. The smaller the amount of heat introduced, the less tendency towards warping. Heavier layers are often advisable.

On a butt weld, unrestrained, one degree of warping can be put into the joint for each pass. A butt weld joining two 1-in. plates, using 8 passes to the inch, will warp 8°; made in 16 passes, nearly 16°.

In the fabrication of fractionating towers by welding, one uses strongbacks to prevent warpage. Trays in such towers have been held to remarkably close tolerances by clever strongback jigs.



Many companies control their metal by peening while the metal is hot, hence can be stretched. Large fillets joining heavy members at exact right angles gain from peening.

Another method to correct warpage is applying heat to the convex side to secure upsetting of the metal, hoping that subsequent shrinkage will bring the structure into correct alignment. Straightening of warped structures is still in the trial and error era.

Finally, the best practice is to avoid warpage in the first place.

When the supply of wiping solder ran low in Iceland, Signal Corps technicians melted toothpaste tubes which they salvaged from their buddies. Solder, consisting mostly of tin and lead, is used to connect electrical circuits in fragile radio wiring as well as wrist-thick telephone cables. It was to splice a cable line that the toothpaste tubes were used.

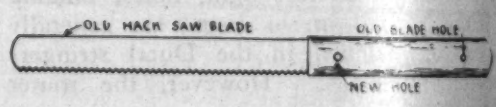
—Publications Branch, War Department

Knife from an Old Hacksaw Blade

by W. F. Schaphorst

In this era of "Don't-throw-it-away," an old hacksaw blade can easily be converted into a knife for cutting piston rod packings and for cutting through numerous metals in places difficult to contact with an ordinary hacksaw.

The blade already has one hole, and we make another by heating red hot locally and punching in preparation for attaching a wooden handle. Rivets



fasten the handle to the steel blade. A new blade may be used in this manner, of course, yet the old one does very well for ordinary cutting jobs.

Arc Stabilizer for Welding

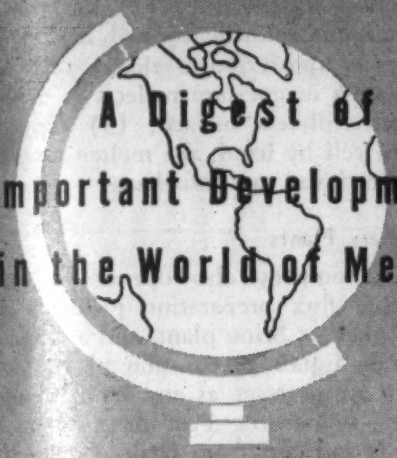
by C. L. Denault, Westinghouse Electric & Mfg. Co.

Welding of thin metals, such as done by aircraft builders, requires small electrodes and low welding currents to prevent burning the thin sheet. But an a.c. arc becomes unstable and may go out easily. Though gas has been used it is more expensive.

D.c. welding was not feasible because of arc blow, and the greater penetration led to burning through.

The problem was solved by superimposing a high-frequency voltage wave (about 250 kilocycles) on the welding current. This keeps the arc stream ionized during the reversals of low-frequency (60-cycle) welding current. As an arc stabilizer, the high frequency provides firm control of very small currents.

Metallurgical Engineering Digest



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New Magnesium Plants

Condensed from
"Engineering and Mining Journal"

The plants of Basic Magnesium, Inc. in Utah turn out more metal than any other magnesium plant in the world, and have cost more money. The mine is far up the side of one of the vast Utah valleys, 300 miles north of the reduction plant, 31 miles from the nearest railroad and 1,100 miles by circuitous rail travel from mine to plant, though eventually trucks will carry the raw material the 300 miles by direct route. In the mine is a concentration of almost pure magnesite, or magnesium carbonate.

At the mine a single blast usually dislodges 10,000 tons of magnesite, which is loaded into 9-yd. trucks that take it either to the crushing plant or to the waste dump, as composition dictates. The magnesite taken to the reduction plant must contain not more than 4% insoluble material, 4.5% CaO or 2% FeO and Al_2O_3. The content of MgO should be about 40%. About 2,000 tons of ore daily has been mined.

The trucks dump into the Allis-Chalmers gyratory crusher with about 6% discarded in the final screening and used for road repair. The usable crushed ore is delivered to a stockpile 350 ft. long, containing up to 45,000 tons. A stacker mixes fresh ore with old, giving perfect distribution.

Concentration is by the flotation process, using the following reagents: aluminum sulphate, sodium metaphosphate, caustic starch, acidified sodium silicate, and naphthenic acid. The magnesite recovery is now 70% as against 48% at the start.

The main reduction plant is a mile long, designed on modernistic lines. There are three main steps in the process: (1) Calcined magnesite, mixed with coal and peat and suitably prepared, is heated in electric furnaces, called chlorinators, in an atmosphere of chlorine; (2) the anhydrous magnesium chloride formed in the chlorinators is transferred to electric cells wherein molten magnesium collects in a pool on the electrolyte's surface; (3) dipped out of the cell by hand, the molten magnesium is refined and cast into bars.

Auxiliary Plants

The company also operates a chlorine plant, a flux preparation plant, a caustic soda plant, a brine plant, and a magnesium chloride liquor preparation plant, most of which are as large as any similar units operating anywhere. Peat moss comes from Canada and coal from Utah. Coal acts as a reducing agent, and the peat moss makes the mixture porous. Experiments are conducted for the eventual elimination of the peat.

The chlorinator and electrolysis buildings each cover the area of a football field, and are divided into two main rooms, in one of which are eight chlorinators and in the other 88 electrolytic cells. A current of 750 amp. is applied to the cell circuit; voltage drop is about 3.3 per cell.

Chlorine is evolved at the anode in the upper part and removed through the top of the cell. Hydrogen forms at the cathode and is removed through the back of the cell. Sodium hydroxide also forms at the cathode and passes out with the waste liquor.

Left behind in the chlorinator is a residue of silica, alumina, iron oxides, etc., which are cleaned out every three weeks, at which time electrodes are changed or dressed. The cells are arranged in eight rows of eleven cells each. They are low receptacles about the size of two bathtubs side by side. Through the covers of the cells project the electrodes, six steel cathodes and three graphite anodes, and an exhaust pipe for the chlorine to leave by.

Magnesium metal forms at the unshielded cathodes and gradually collects in a pool on the surface of the chloride. When several inches deep, two men dip out the molten metal into a gas-heated ladle for transfer to the first casting operation, the metal being removed from each cell once a day.

The cast pigs now go to the refinery, being melted in small pot furnaces. A flux, consisting of powdered metal chlorides and fluorides, is stirred through the molten metal, and the resulting sludge allowed to settle. A reducing atmosphere surrounds the metal until it solidifies.

—R. H. Ramsey, *Engineering & Mining J.* Vol. 144, Oct. 1943, pp. 61-67.

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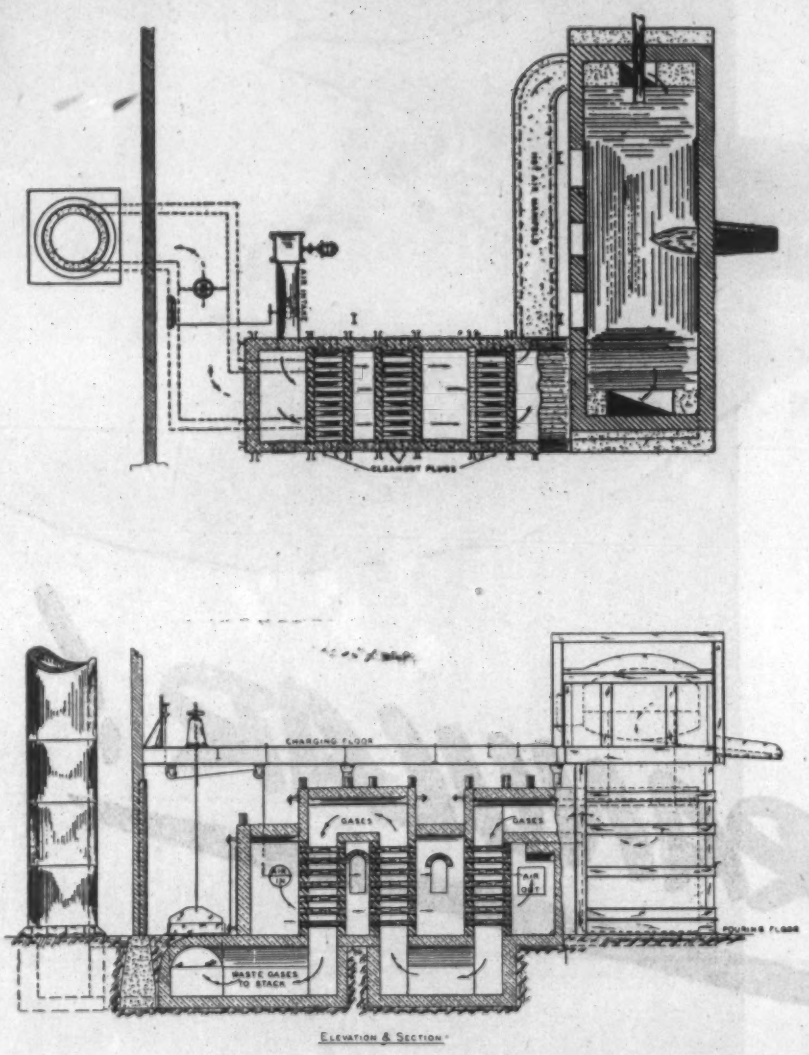

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Double-Spout Ladle

Condensed from "Stahl und Eisen"

The efficiency of cranes can be materially improved in steel mills with limited crane facilities by providing the pouring ladles with two plug holes. Shortening the tapping time of the ladle results in a longer life of the ladle and in considerable savings in refractories.

Further savings accrue from the fact that the new method permits pouring a great number of ingots by top casting. This is not feasible when using a single-plug ladle, due to the longer tapping time required. With a shorter teeming time, the danger of plug leaks is reduced.

When tapping a ladle in 15 min., a surprisingly small wear and tear of the plug and teeming nozzle results. The filling of the ingot molds is not accelerated. The new method may be compared to the pouring from two ladles. It naturally calls for close team-work between the ladle and the pit crews. The shorter tapping times constitute a relief of both crews, particularly during the summer.

When casting a great number of small ingots or castings, double-plug hole tapping offers particularly great advantages. A number of typical examples is discussed by comparing the old method with the new.

The pouring funnels, which could be slightly raised, were attached to the bottom of the ladle in casting wheel tires and solid wheels from a 65-ton two-hole ladle, resulting in a considerably shorter tapping time. In another case the pouring of 100 ingots of 300 kg. each (30 tons) formerly took 90 min., while 240 ingots of 200 kg. (48 tons) were cast in 80 min. with the new method.

Some mills employ two ladles, and often two open-hearth furnaces, in casting large ingots of 60 to 80 tons. The two-hole ladle simplifies this operation.

—Alfred Mund. *Stahl u. Eisen*, Vol. 63, July 22, 1943, pp. 509-513.

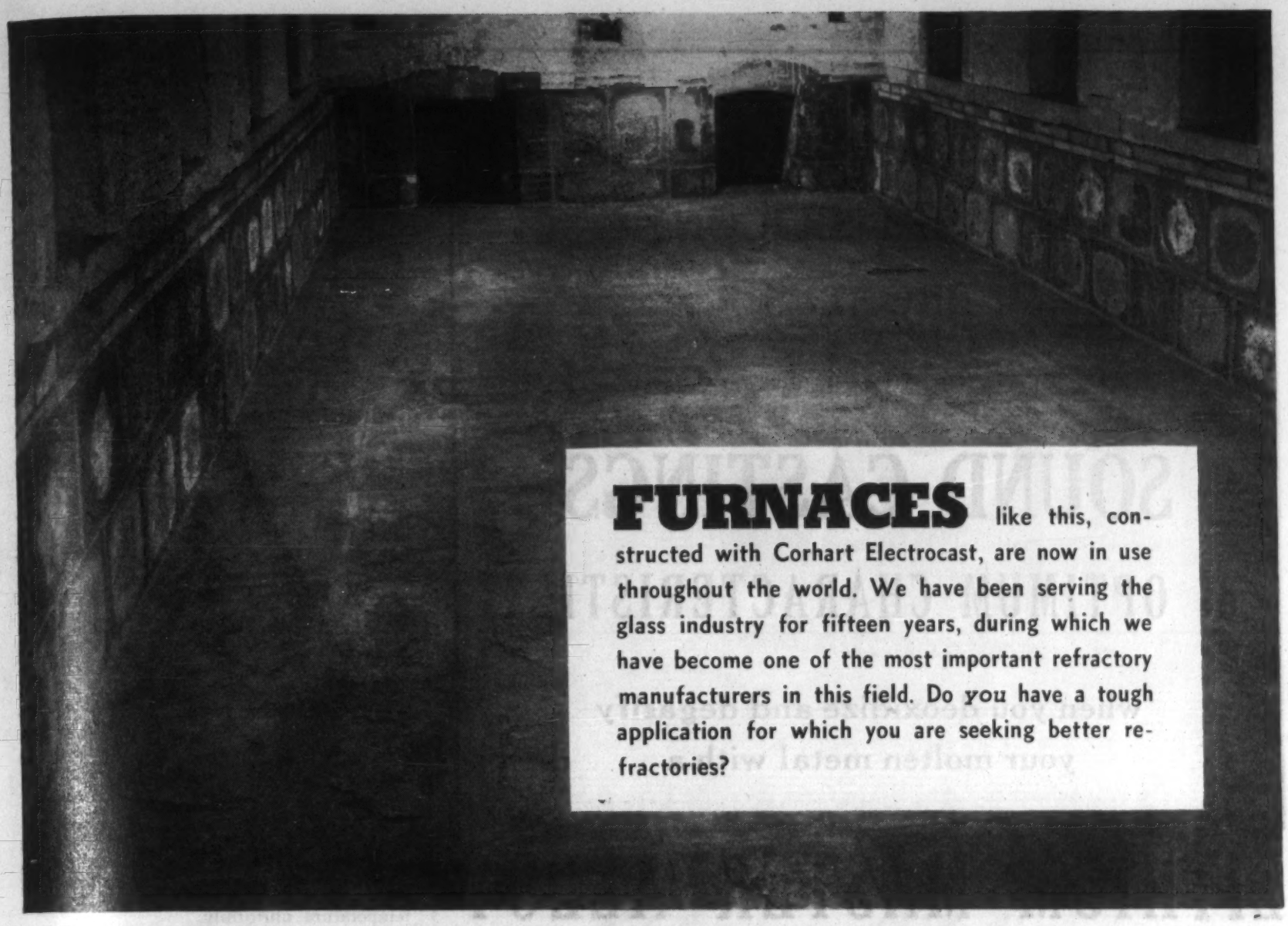
New Soaking Pit Design

Condensed from "Iron and Steel Engineer"

Increased demands upon quality and quantity in recent years have brought about changes in soaking pit design and operation. Continuous rolling has made large tonnage demands on soaking pits.

The newer pits have various shapes—round, square and rectangular. In one type the fuel enters the bottom and exhausts at either side; in another the exit and inlet ports reverse at intervals; while in still another the fuel enters from each end and the waste gases leave in the same manner. The design of the latter pit gives uniform heat distribution to both the top and bottom of the ingot.

The pit is fired by two burners directly opposed to each other in opposite end walls, with the burners located close to the bottom of the pit. These two flames meet in the middle of the pit and are forced to the top and side walls of the pit. They then travel along the back of the ingots to the flue openings, which are located in the four corners of the pit. The gases there pass directly through the pit recuperator and thence to the stack.


FURNACES like this, constructed with Corhart Electrocast, are now in use throughout the world. We have been serving the glass industry for fifteen years, during which we have become one of the most important refractory manufacturers in this field. Do *you* have a tough application for which you are seeking better refractories?

The entire flux walls and bottom of this 16' x 56' glass furnace are constructed of Corhart Electrocast blocks.

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HERE'S another item to add to your "mental file" on Corhart* Electrocast bottoms.

In March, 1942, a well-known glass manufacturer installed his first uninsulated Corhart Electrocast melting-end bottom. On the strength of its performance, this customer has now installed another uninsulated Corhart bottom in another of his tanks. Both are of 12" Corhart Standard Electrocast.

But these two tanks are by no means the only ones in which uninsulated Corhart bottoms are now being used.

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TIN and SILICON
BRONZES
yield

SOUND CASTINGS
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when you deoxidize and degasify
your molten metal with a

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In molten copper and tin- or silicon-bronzes, Lithium reacts readily with such harmful impurities as gases (hydrogen), oxides, sulfides, or other non-metallic impurities. Owing to its very low specific gravity (1/18 of that of copper) these Lithium compounds rise quickly to the surface. Thanks to its very low equivalent weight, less than 0.01% Lithium is sufficient in most cases.

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Application of a silicon carbide recuperator to the pit is made to give sufficient air preheat and for reducing the waste gas temperature to a temperature that is easily handled by the stack damper and flue brickwork without damage. The recuperator is of sufficient area to maintain approximately 1000° F. of air preheat temperature.

Air is supplied to each row of pits by a cold-air fan at a pressure of about one in. water at maximum flow. The system of forcing air through the recuperator under pressure allows the measurement of combustion air under standard conditions.

The burner construction must give uniform air velocity to the burner port so that proper mixing can be obtained. The rate of mixing with preheated air is a very important factor in obtaining a uniform pit temperature.

A burner has been developed that gives uniform temperature to all ingots from the middle of the pit back to the corner. Pits are now in operation that give a uniform heat of ingots top and bottom, and uniform in regard to ingot location.

Pits are controlled by a combustion ratio regulator, which adjusts the air flow in volumetric proportions to the flow of fuel. The stack damper is adjusted by a furnace pressure regulator to maintain constant pit pressure. Two thermocouples are inserted in the side wall of the pit in close proximity to the top of the ingots for temperature control and measurement.

The time of soaking in the new pit is short, since the surface temperatures on all parts of the ingot are brought to rolling temperature uniformly.

—Joseph Sparks. *Iron & Steel Engineer*, Vol. 20, Nov. 1943, pp. 48-52.

Economies with Ramming Mix

Condensed from "Brick and Clay Record"

The use of Harbison-Walker Magnamix permits the installation of a complete hearth to its finished contours before heat is applied. This allows steel to be made within a few days with saving in labor and time.

Magnesite suitable for refractories is obtained from seawater by the Chesney process by Northwest Magnesite Co., a subsidiary of Harbison-Walker.

H-W Magnamix contains about 80% magnesia, largely in the form of periclase. Sintered bottoms of magnesite grains usually contain as a bond 15 to 20% added slag, which dilutes the magnesia. H-W Magnamix is installed without slag and, therefore, magnesia is not diluted.

When properly rammed, an H-W Magnamix bottom has a cold crushing strength of 1500 psi, a modulus of rupture of 350 psi, and density of 165 to 170 lbs. per cu. ft. It contains about 130 lbs. of periclase per cu. ft.

Another feature of Magnamix is that hearths are rapidly installed with common labor. Complete open-hearth furnace bottoms have been placed at the rate of over two tons per hr. Ramming may begin immediately upon completion of sub-bottom, front and back wall and roof, and proceed simultaneously with the construction of parts and end walls. Contours of the hearth and the working surface are established completely before any heat is applied.

TONNAGE USED 1941 (PART)

TONNAGE USED 1942

1943 TONNAGE

Acceptance Proves Value

HEARTH PATCH is a war-born refractory that has made good.

Open hearth men, driving furnaces for more and more steel to meet war needs, called for an emergency patch material . . . something that could be dumped into large bottom holes to make strong, safe repairs with least delay. Hearth Patch was the answer.

Just how well Hearth Patch serves this purpose is demonstrated by its steadily growing acceptance. Month after month, the tonnage used increases. New customers are trying it, liking it, becoming regular users.

Hearth Patch is designed for quick, emergency repairs. A fine-grained, fast-setting magnesite, it is intended to be thrown quickly, without slag addition, into deep holes while the furnace is still very hot. Properly applied and given a working surface of dolomite clinker, it sets into a dense repair.

Hearth Patch has been much improved in its development over the past three years. It is now a Ramix-type product of high fusibility, greatly increased refractoriness, and remarkable stability.

Our Service Engineers are prepared to assist your personnel in proper ways to use Hearth Patch and other Basic Refractories products—to help you make maximum savings in production time with good refractories.

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Installation of Magnamix is as follows: The magnesite or chrome brick in the sub-hearth are swept and brushed with liquid sodium silicate to form a thin glazed surface on which to ram the bottom. Before applying Magnamix this glazed surface is swept clean.

Two forms, made of 2-in. planking cut to conform to the profile of the sub-bottom, are placed across the furnace. The forms should be slightly higher than the desired thickness of Magnamix. Ramming may begin at the taphole, building up to the required elevation to permit placing the pipe.

A four to five in. thickness of magnamix is sufficient for ramming at one time to a thickness of 2½ to 3 in. The rammed surface of each layer should be scratched ¼ to ½ in. to insure bonding with the next layer.

The completed surface must be dried with a wood fire, the temperature raised to 300 to 400° F. in 12 to 16 hrs. The furnace is then lighted, and the temperature is raised gradually over a period of at least 24 hrs.

—*Brick and Clay Record*, Vol. 103, Sept. 1943, pp. 55-56.

Continuous Casting of Aluminum

Condensed from "Metallurgia"

This article discusses what is termed as a noteworthy advance in the perfection of a process for the direct cooling of ingots and "billets" while they are being poured.

This is a development by the Vereinigte Leichmetal-Werke, of Hanover, Germany, which is described in British Patent Specification No. 492,216. In the process as developed, the metal is poured into a short water-cooled mold from which the bottom is lowered at such a rate that the ingot is not completely solid when it leaves the mold, thus permitting cooling water to come into direct contact with the ingot metal almost immediately after casting.

For casting aluminum containing 3.5 to 4.5% Cu and 0.6 to 1.4% Mg and Mn, an example is cited in which a mold may be 25 to 30 cms. in diam. and 16 to 20 cms. long into which the metal is poured to within 4 to 5 cms. of the top and the ingot lowered at the rate of 50 to 90 cms. per min. Several methods of cooling the mold and the ingots are given in the specifications.

Several methods of chilling ingots have been devised, and they include the employment of copper molds, water-cooled iron molds, and molds made of light steel sheet, which are submerged in water either before or immediately after casting.

The remarkable improvement in the metallurgical structure of the ingots produced by direct cooling prompted the V.L.-W. to carry out more thorough and exhaustive experiments, with the result that they arrived at a means whereby, to use the terms of the Patent Specification mentioned above, "the molten metal is poured into a short water-cooled mold, the bottom of which is lowered meanwhile at such a rate in relation to the rate of pouring that the level of the molten metal remains more or less constant, where the rate of pouring

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Ferrisul's action as an etching agent is easily controlled, yet extremely rapid—as high as 30 times that of sulfuric acid . . . Thus it produces a sharp, fine-grained uniform etch . . . is now being used with outstanding success on steel cartridge cases before drawing.

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When used on straight chrome steels, Ferrisul pickling solutions have effectively removed all scale with very little, if any, metal loss . . . There is no fuming . . . The bath is easily analyzed . . . Chemical costs are lower than with other treatments.

For Pickling Copper Clad Steel

By adding Ferrisul to an inhibited acid pickling bath for copper-clad steels, *both* red and black scale are removed in *one* bath . . . thus producing a quick, complete pickle . . . aiding subsequent drawing operations . . . and reducing rejects due to surface blemishes.

For Pickling Nickel

For Etching Low Alloy Steel

For Pickling Aluminum Bronze

Laboratory and plant tests have proved Ferrisul also has definite advantages in these treating problems, and recommended procedures have been worked out for each.

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is of such magnitude compared with the size of the mold that the ingot has not yet completely solidified through the center when it leaves the bottom of the mold, this (complete solidification) only taking place subsequently by direct contact with the cooling liquid.

Continuous Pouring

Since there is no fixed bottom to the mold, provision can be made for pouring to continue as long as required. For this reason, this method of casting is sometimes described as the "continuous casting process."

After a number of trials it was found that the mold could be shortened very considerably, and the chief novelty described in the Patent Specification under reference is that the mold is shorter in vertical height than the smallest diameter of the ingot, billet or slab being cast.

At first it was thought that the shortening of the mold might result in a very considerable slowing up of the rate of pouring, if the solidified walls of the ingot were to be sufficiently strong to contain the molten interior metal, but in practice it was found that cylindrical billets of over 40 cms. diam. could be cast at speeds of up to 15 to 20 cms. per min., provided that an adequate supply of cooling water at approximately normal temperature was available.

It seems probable that the importance of the direct cooling process has not been sufficiently appreciated in this country [England], since many manufacturers so far have failed to avail themselves of the many advantages accruing from it. One of the latter is that the much improved properties obtained in some duralumin types of alloy sheet, rolled from directly cooled slabs, permit of the specified mechanical properties being obtained while using much lower magnesium content than would be required when employing slabs cast in ordinary chill molds. Similar improvements in properties are obtained in extruded sections or forgings made from directly cooled billets.

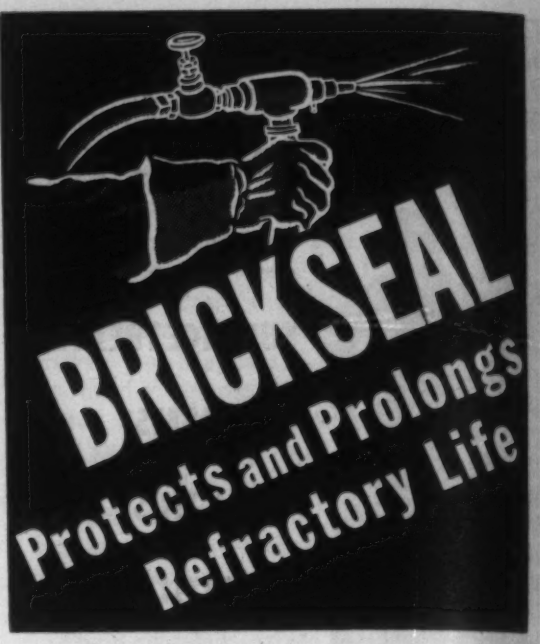
—*Metallurgia*, Vol. 28, Sept. 1943, pp. 249-250.

German Wartime Metallurgy

Condensed from
"Engineering and Mining Journal"

An important source of copper and tin for Germany was church bells. They were exploded with dynamite, then the lumps were either remelted in a cupola and charged liquid, or the Bessemer converter was blown hot with coke and charged with the lumps. In the anodes poured from the converter the main surprise was the noble metals, it then being recalled that many bells were antique before present days of refinements of metals separation.

In the Bessemerizing silver, more volatile than gold, was partly driven over with the baghouse dust, later reclaimed in the tin operations. Antimony, nickel and bismuth were bad impurities in the anode material, while lead and zinc spoiled the tin flue dust.

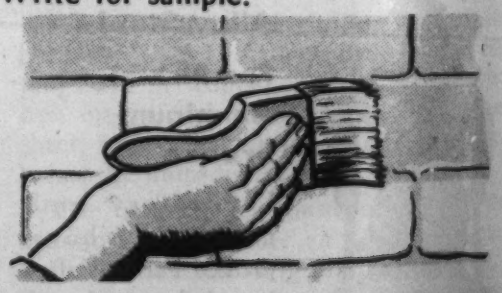


Applied like paint, prevents cracking and spalling

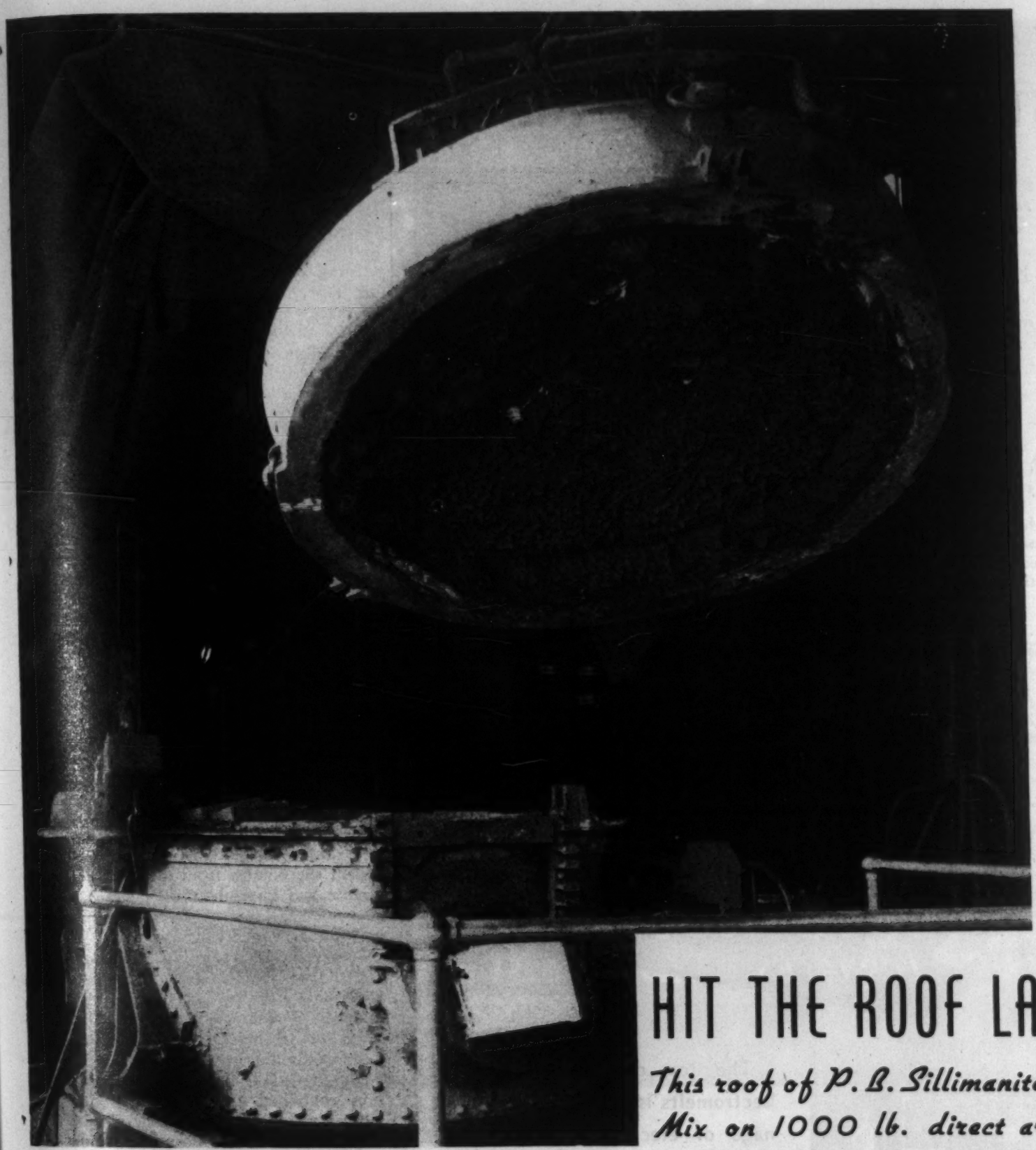
Now, more than ever, anything which prevents interruption of furnace production is of vital importance. Brickseal refractory coating prolongs the life of new or old brickwork by preventing disintegration due to cracking, spalling and slagging.

Brickseal consists of high-fusion clays and metals combined in oil. Furnace heat drives off the oils and vitrifies the clays and metals, permanently binding the bricks with a highly-glazed, vitreous, monolithic coating, impervious to gases, carbon and air infiltration. The highly reflective surface keeps heat inside the furnace and increases its efficiency.

At operating temperature Brickseal becomes semi-plastic so that it expands and contracts with the wall, and therefore cannot crack, peel or blister due to sudden temperature variations. This feature also enables Brickseal to bind loose brickwork and old cracks. Slag and clinkers can be removed without damage to lining. Brickseal is applied easily with brush or spray gun, and the furnace may be fired at once. At very little cost, Brickseal will assure longer, uninterrupted production. Write for sample.



BRICKSEAL
REFRACTORY CO.
1029 CLINTON ST., HOBOKEN, N. J.



HIT THE ROOF LATELY?

This roof of P. B. Sillimanite Ramming Mix on 1000 lb. direct arc furnace, melted a total of 1650 heats, chrome nickel alloys

Either P. B. SILLIMANITE Ramming Mix or Brick and Shapes are supplied for the roofs of the smaller furnaces — 1000 lb. and under. Brick and Special Shapes are recommended for the larger roofs. Write today for your copy of Bulletin No. 311, and other interesting data.

ROOF	HEATS MELTED	ROOF COST PER HEAT
P. B. Sillimanite Ramming Mix	1650	0.068
Silica	150 avg.	0.31

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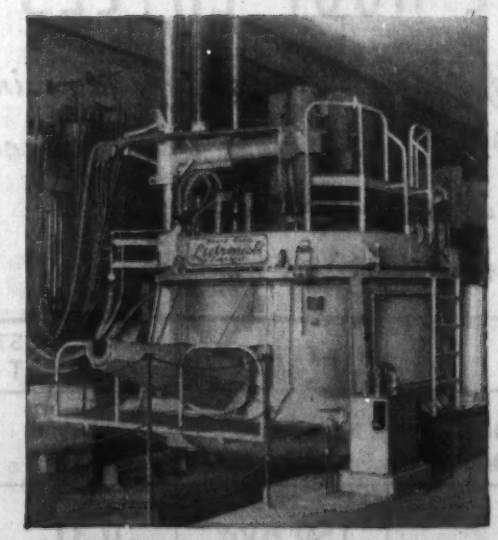
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces*

MOORE RAPID Lectromelt FURNACES



The top charge feature of Lectromelts is boosting the tonnage of electric steel departments. Improvements in furnace design permit quicker charging and less time between heats.

The illustrated top charge Lectromelt pours an average heat of 10 tons of quality steel. Lectromelts are available in sizes from 100 tons to 25 pounds capacity. Write for complete information.

ARMY E NAVY

PITTSBURGH LECTROMELT FURNACE CORPORATION
PITTSBURGH, PENNSYLVANIA

The converter slags had to be recycled in blast furnaces, using additional copper materials from different sources. Total tin losses, from bronze to collected flue dust, may have been 10%, while the copper recovery as anodes, including recycling losses in slags, may have been 95%.

The most interesting and difficult problem of the Germans working with tin was the treatment of "glanzmetall" alloys derived from reclaiming bearing metals. This is the remaining crust after a ternary, consisting of 3.5 Sb, 58 Sn and 38.5% Pb, is tapped off a kettle-like reverberatory furnace.

Recovery of the noble metals therein was the incentive for a complicated process. The mixed oxides were reduced in a reverberatory or blast furnace, blowing down the metal in a converter where noble metals remain behind in an alloy with copper and antimony, while the oxides of lead and tin containing little antimony are caught in a baghouse.

The converter copper, high in noble metal and antimony, went to a sulphate electrolysis, while the oxides were separately reduced in a reverberatory furnace to a metal that was either electrolyzed in a sulpho-stannate bath, if it contained more than 80% Sn, or was sold for solder or bearing alloy.

Bearing Metals

Calcium-hardened lead bearing alloys are used to the extent of 5,000 tons yearly in German railroads as "bahnmetall." While in this country preference was given fusion electrolysis in making such alloys, the two processes used in Europe are both chemical.

Germany is self-sufficient in vanadium, which she obtains from the minette ores of France and Luxembourg, containing 0.07% V, which yields a pig iron containing 0.10 to 0.15%. Vanadium is separated from pig iron chiefly by oxidation. This oxidation by FeO takes place in the presence of acid slags only after most of the manganese and silicon are eliminated. Recovery from minette ore reaches 50 to 60% of the vanadium content.

As to nickel, the German Frankenstein ores contained 1% associated with iron. They are reduced to a ferronickel with 10% Ni, then the iron is Bessemerized out to a 40% nickel alloy, at which point some nickel starts slagging. Bessemerizing may be continued to form nickel-bearing slags, to be separately reduced to a low-grade ferronickel slag and a high-grade ferronickel metal.

As to zinc, Germany is greatly indebted to the United States for methods of producing high-purity metal andu sing it in zinc alloys, introduced by the U. S., where they serve mainly as die-casting materials. In Germany they are used widely as a brass substitute in extruded and rolled shapes.

With respect to magnesium, early in 1939 Germany was operating plants that produced it by thermal reduction of dolomite with carbon, silicon and calcium carbide, but the greater part still comes from electrolysis of magnesium chloride, which, in turn, is produced by reacting magnesium oxide with chlorine and carbon in an electric furnace, such as used by Basic Magnesium, Inc., here.

—W. J. Kroll. *Engineering & Mining J.*, Vol. 144, Sept. 1943, pp. 50-51; Oct., pp. 82-83, 104.

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Tungsten high-speed steel can now be made and used as needed. With minor exceptions, restriction is off. A better balance between need and supply has made this possible.

So resourceful have been our metallurgists and plant production men, and so fortunate our access to alternative materials, that during the months when Tungsten was scarce, our output of high-quality steels was not greatly impaired. But now that Tungsten is again obtainable, many manufacturers are returning to it for uses in which it has long been the standard material.

Inquiries concerning the availability or the metallurgical behavior of Tungsten, Molybdenum, or Boron will be welcomed by the Molybdenum Corporation.

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Casting 500-Pound Bombs

Condensed from "Foundry Trade Journal"

A practice used for the mass-production of green-sand molded 500-lb. bombs utilizes a maximum of steel scrap and a minimum of ferro-silicon. The system was based on a new theory for the operation of the side-blown converter, the synchronization of mold assembly and other jobs with the time taken to pour a predetermined number of castings, and a new system of sand cooling. The theory postulates the notion that silicon in the charge is unnecessary, provided the metal is superheated to a temperature equivalent to that in the vessel when carbon begins to react with oxygen of the bath.

For the manufacture of these 500-lb. bombs, a British foundry uses 20-ton-per-hr. cupolas, 12½ ton rotary furnaces, and a battery of 3½ tons capacity side-blown converters. The cupolas are blown by electrically-driven positive displacement blowers. The cupolas are provided with a deep well to facilitate carbon pickup from the coke bed.

Low phosphorus material not being essential for this particular production, the iron produced by these cupolas has the following average analysis: 2.7-2.8 C, 0.1-0.2 Si, 0.3-0.5 Mn, 0.12-0.15 S, 0.06-0.07% P. Using 30 lbs. of soda ash per ton, sulphur is reduced to an average of 0.035%, but can be reduced still further when required. The accompanying silicon loss is small.

The metal is transferred to the rotary furnaces, which are fired by pulverized anthracite. In the rotary furnaces the temperature of the metal is raised by 200° C. (360° F.) without change in composition. Apart from superheating, these furnaces also act as mixers.

From the rotary plant the metal is transferred to the side-blown acid converters. The composition of the steel leaving the converters will average: 0.23-0.25 C, 0.3 Si, 1.3-1.4 Mn, 0.03-0.04 S and 0.06-0.07% P. Teapot lip pouring ladles receive the metal from the converters, and are transported to the pouring position alongside the mold conveyor. The metal losses are about 5% in the cupola, and 5 to 7% in the converter.

Sand Coolers Used

Before machining, the bombs are heated to 950° C. (1740° F.), soaked at 950 to 972° C. (1740 to 1780° F.) for 2½ hrs., and cooled over a period of 5½ hrs. Large tonnages of sand are being effectively cooled in large (Buttner system) rotary drum coolers, each handling up to 30 tons of sand per hr. The drums are 43 ft. long and 7 ft. 10 in. in diam. Each cooler is provided with a large centrifugal fan that draws the cooling air through the drum counter to the sand flow.

The bogies carrying the cores are pushed through continuous drying stoves of the gas and hot air continuous recirculating type, operating to 210° C. (410° F.). Each stove is divided into three zones, preheating, soaking, and cooling, the first using waste heat from the hot castings, assisted by coke-oven gas.

For making the molds a battery of sandslingers and a pair of down-drawn

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Truline cores ram quickly, giving dense cores with freedom from sagging. *This means more cores per hour per core maker!*

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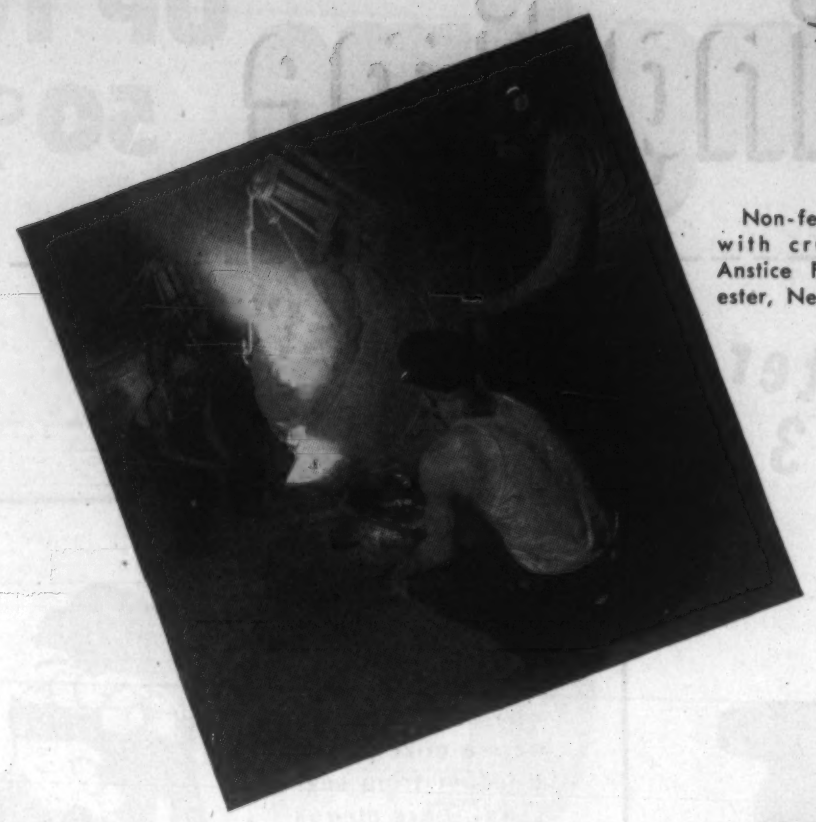

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molding machines are used. The hot castings are placed on specially-constructed bogies traveling on two tracks, each bogie carrying eight bombs, which are propelled through two cooling chambers by electrically-operated, screw-type pushergear. Air is drawn from beneath the bogies and is taken to a large blowing fan at the discharge end, where it is picked up by exhaust ducts.

The hot air so generated is led for use with the core stoves as described above. Each bomb is tested under water to an air pressure of 40 psi.

—*Foundry Trade J.*, Vol. 71, Oct. 7, 1943, pp. 101-106, 100; Oct. 14, pp. 119-124, 128

Casting to Specification

Condensed from "Canadian Metals & Metallurgical Industries"

Current problems of the foundry industry are considered under three headings: (1) specifications, (2) questionable products, and (3) rectification of faulty castings.

The requirements set down in specifications for castings are necessary, because castings are subjected to water and air of varying composition, temperatures and pressures, each of which is a factor in determining the suitability of a product for the work it is required to perform.

The particular mechanical conditions under which the castings must serve and the stresses thus involved have an important bearing upon the qualities required in the casting. In writing the specifications some leeway must be granted because of the possibilities for faulty operation of the machine when in service.

Aerial bombing is a factor affecting the rigidity of casting specifications. In some instances the damage done to main propelling machinery, auxiliaries, piping and shafting on shipboard and to heavy punching machinery, shearing machinery, and all types of machine tools in factories by near misses of aerial bombs is hardly believable.

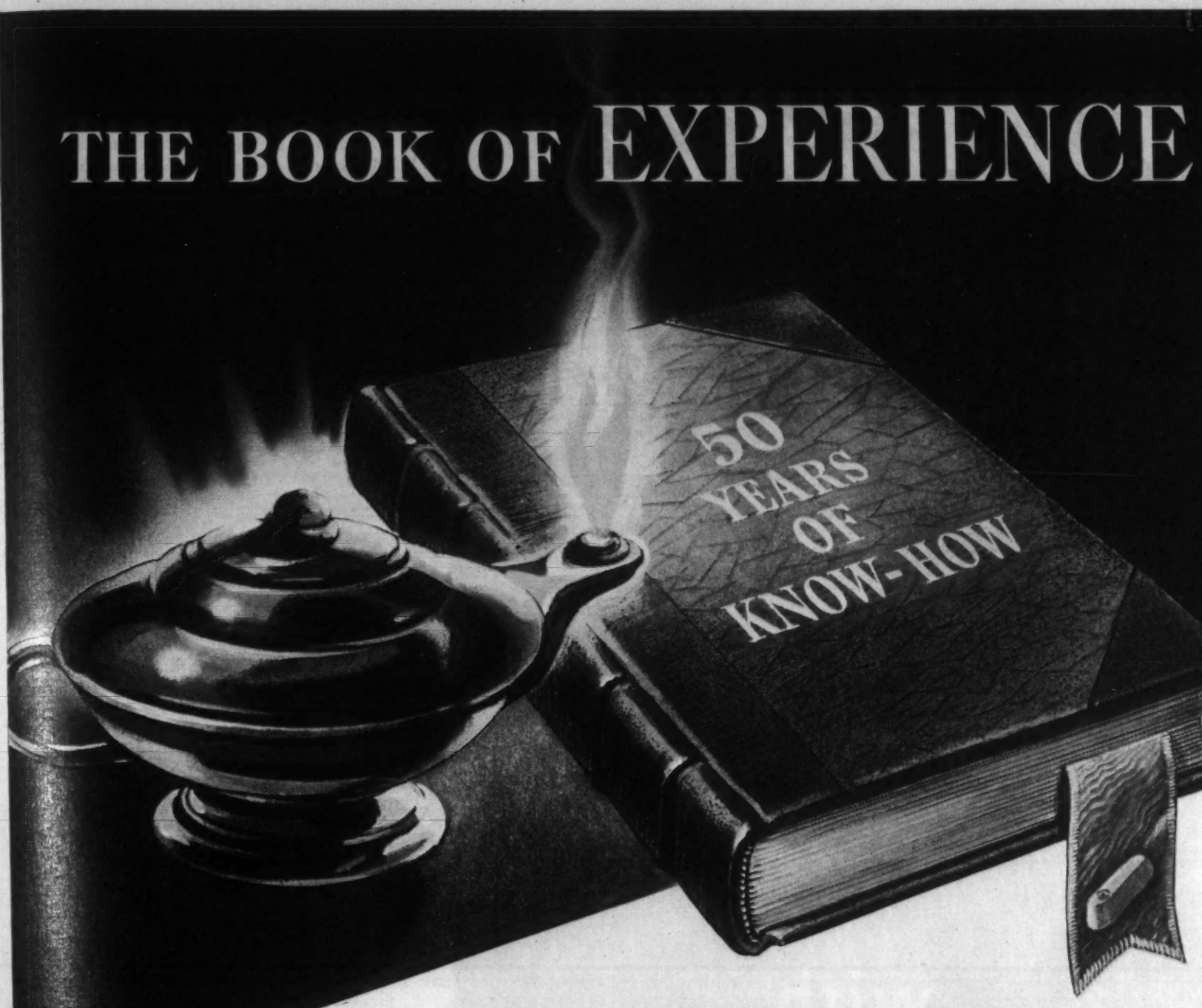
Another factor in specification making is the introduction of substitutes due to the lack of materials regarded as the best known. The purpose for which the casting is to be used determines the desirability of attempting to rectify defective castings. The type of salvage operation depends on the nature of the casting and the work that it has to perform.

The working conditions of castings should be given thorough consideration before any repair job is undertaken. Nonferrous alloys are adaptable to repair by burning, but the operation must be done by men well qualified and experienced.

Generally, in cases where the proportion of defective castings of a particular type is high, the following points should be checked: (1) The design from a foundry point of view; (2) method of molding, gating and venting; (3) temperature of pouring; and (4) type of sand being used for the cores.

A machine shop should give due consideration to a foundry planning department in conjunction with the machine shop

THE BOOK OF EXPERIENCE



If the knowledge accumulated by Michigan Smelting in its 50 years of specialized experience were gathered together, it would form an authoritative and basic reference book covering this entire industry. Non-ferrous scrap metal refining has been our business for half a century. The sound technical knowledge and wide practical experience possessed by our executive staff is at your disposal. When you are in the market for non-ferrous alloys, consult us for your requirements, no matter how rigid, exacting or unusual.

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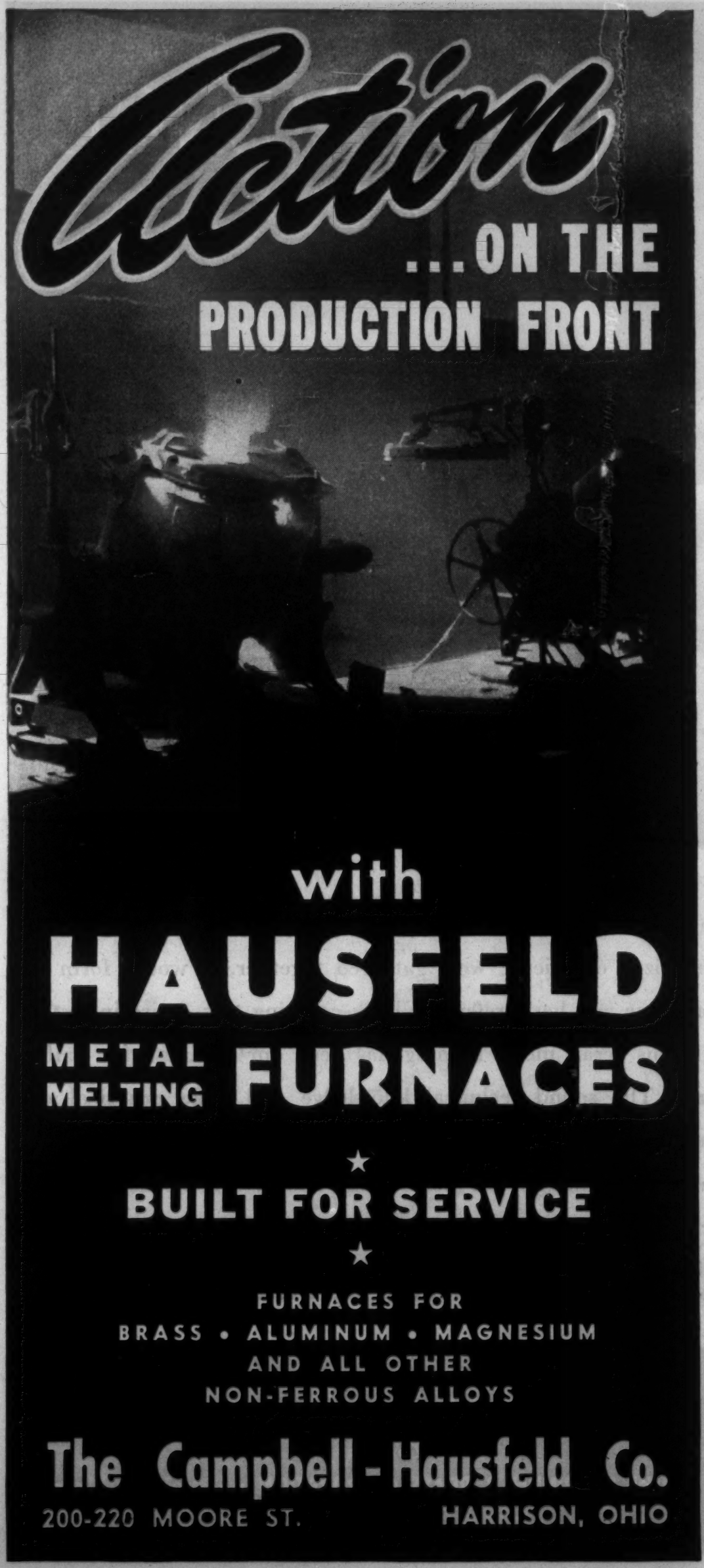

production department, with the final design not accepted until all parties have had an opportunity to reconcile their views.

Where difficulties are being experienced with the production of good castings, a committee of the American Foundrymen's Association should be in existence in order that the foundry concerned might put its problems before such an experienced group.

—*Can. Metals & Met. Indst.*, Vol. 6, Oct., 1943, pp. 38, 40

Efficiency in the Foundry

Condensed from "Western Metals"

The Atlas Foundry and Machine Co., Tacoma, Wash., is an unusual jobbing foundry, being an integral operation from patterns to finished production. Castings are of ferrous and non-ferrous metals, including light alloys. Each type of foundry operates independently, with over 300 employees altogether. Buildings are spotlessly white, with green trim, all areas between buildings being asphalted.

Walls of the pattern shop are of glass, an underfloor duct system removing all dust. All machines are direct drive, and overhead unit gas heaters serve in winter. Atlas can turn out intricate pattern work of large size, such as stern frames for ships, 30 ft. long. Much woodworking and tool grinding machinery equip the pattern shop. Over 100,000 live patterns indicate that this is one of the largest pattern lofts on the Pacific Coast.

A battery of sand mills mix electrically facing and backing sands. Molding machines and jolt-squeeze machines are modern. An Electromelt 3-phase electric arc furnace, ranging up to 3000° F., turns out 4 to 6 tons per batch. Laboratory control is applied to each heat, with preliminary analysis before pouring. Among testers are those for hardness, tensile strength, arbitration bar and X-ray equipment. A recent interesting job is casting hoist differential housings with much variation in thickness, ⅜ to 1¼ in.

In the core room, window-walls are blue-painted, making for only 2% light intensity loss, omitting 90% of the glare. Mechanization is carried through in core cutters, rod straighteners, cranes, hoppers, drawing machines, etc. Two Mahr oil-fired heat treat furnaces, with Brown automatic controls, are adjacent to the cleaning room. Typical are crane wheels, from which gates and risers are removed with an acetylene torch, then heated to 1600 to 1700° F. for annealing. One hour per in. of thickness is the general time rule.

In the cleaning room is Pangborn equipment, including a dust collector moving 27,000 cu. ft. of air per min. and a roto-blast unit. Also, exhaust lines serve the Marsche grinders. Ingersoll-Rand air compressors serve the air lines. Other equipment is a liquid oxygen plant and an Oxweld acetylene generator.

—*Western Metals*, Vol. 1, Oct. 1943, pp. 26, 27.

The widest possible application of "Shamva" Mullite super-refractories to your furnace construction, will provide a definite impetus to production because—

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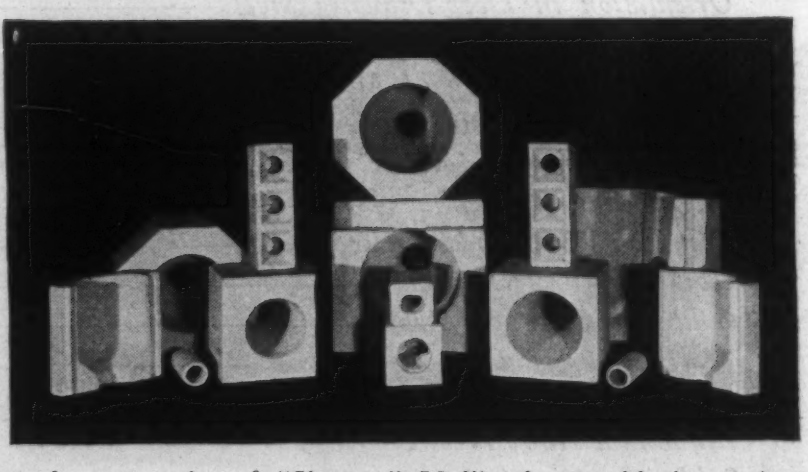

A few examples of "Shamva" Mullite burner blocks made in endless variety, with exacting adherence to specifications.

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Assembling Metal Components

Condensed from "Sheet Metal Industries"

When new work is in progress, the designer is frequently blamed for all production difficulties. Sometimes this is justified. However, no new design should be issued to the factory until a joint conference of designers and production engineers is held.

The designer should have guidance as to the process to be used. If several methods are possible, the choice will affect his design. The choice of the process of assembling depends on the total number of items and the required rate of production. The permanence of the assembly must be taken into consideration. If the items are permanently assembled, the choice is wider than if they must be capable of being taken down for cleaning and repair.

The desired strength of the assembly may also affect the choice of joining means. The strength of a soldered joint is generally taken as equal to the strength of the solder, although higher strengths may be obtained due to surface alloying.

Copper brazing in a hydrogen atmosphere will give greater strengths. Furthermore, copper at 1100° C. in a hydrogen atmosphere will flow several inches into a pressed fit, whereas this penetration is not easily obtained by silver soldering or flame brazing. The strength of welds is taken as equal to that of the parent metal.

The consistency and reliability of the processes chosen is a most vital factor upon which will depend the methods of control. Where the quantities involved are large, it is necessary to eliminate as far as possible the human factor and to control the sequence of operations.

Any required strength of joint may be obtained by riveting with a suitable choice of the size and number of rivets. Frequently the assembly to be riveted is a complex of metallic and non-metallic parts that will not stand high pressures without cracking. It is then necessary to use hollow rivets or rivets of a non-ferrous metal with a comparatively low yield point.

Spot Welding

Spot welding is in many cases, quicker and cheaper than riveting, but it has definite limitations. It is applicable to all steels with less than 0.2% C; with higher carbon contents, the welds are apt to be hard and brittle and may be cracked unless special techniques are used.

Brass, silicon bronze and many other non-ferrous metals can be spot welded successfully, but they require accurate automatic control of current, heating time, and pressure. No designer should specify spot welds in aluminum unless his shops are equipped with adequate welding machines and the plant necessary to remove oxide film from the surface before welding. An accuracy of assembly equal to that obtained by rivets may be obtained by spot or projection welding if suitable welding fixtures are used.

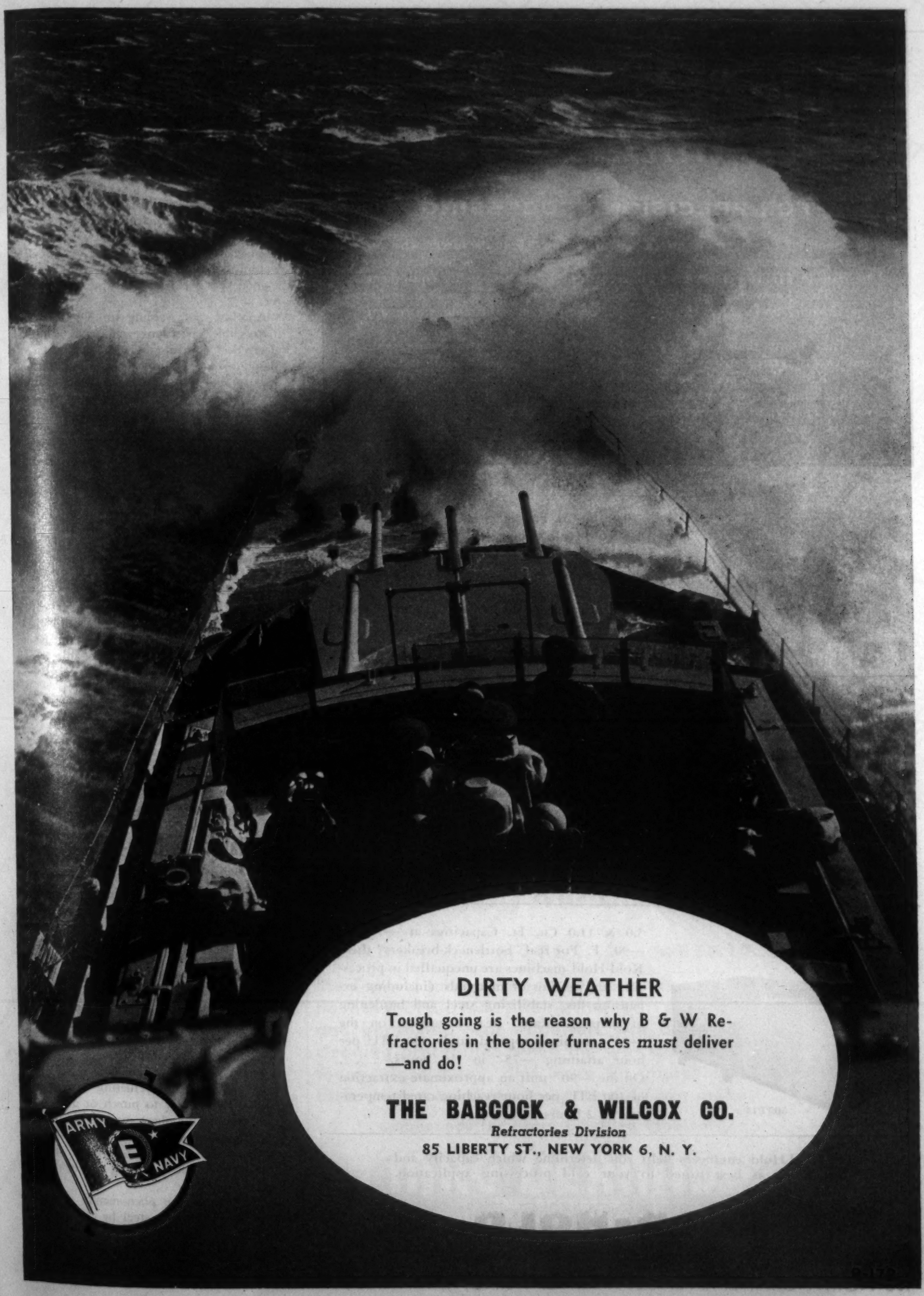
The application of the spot- or butt-welding machine as a riveting machine is not as widely known as it deserves to be. The spot or butt welder enables the rivet to be heated in position and pressed while hot. The rivet tightness is several times greater than can be obtained by any cold method. Furthermore, it can be used with small rivets, which are unsuitable for furnace heating as they would cool down excessively before they could be introduced into the holes.

Spot welding has a low fatigue strength where there is a relative movement of the parts. Copper brazing is better in such applications.

For the large scale assembly of such parts, various electrical methods of heating are often useful. For example, an item being soldered may be heated by carbon rods or blocks in contact with the work or by direct resistance heating. High frequency heating is also worthy of consideration.

Process Limitations

Various process limitations must be considered. Soft solders rapidly lose strength as the temperature is increased, so they are not satisfactory for parts to be used at elevated temperatures. Another important



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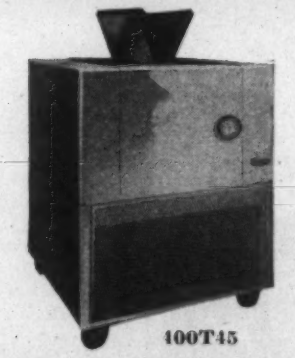

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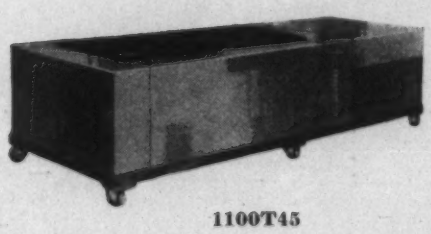
2.0 & 4.0 Cu. Ft. capacities at —45° & —60° F. Kold-Hold's most popular models. High efficiency, low cost maintenance and portability have established their acceptance in rivet storing, aging of steel and steel parts, chemical processing and pitch removal from optical lens. Designed for heavy duty.



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5.4 & 11.0 Cu. Ft. Capacities at —45° & —60° F. Virtually every application utilizing sub-zero processing can use these units to good advantage. Wherever —45° to —60° F. temperatures in these capacities is specified for cold processing, Kold-Hold units in this series are selected. In expansion fitting, aging of metals, aluminum alloy storage and numerous other applications, these machines provide reliable, fast, efficient low temperature performance.

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5.0 & 11.0 Cu. Ft. Capacities at —75° & —90° F. For real "bottleneck-breakers" these Kold-Hold machines are unequalled in processing and testing of materials (including expansion fits, stabilizing steel and hardening of metals). Rated heat extraction on the —75° machines approximately 300 BTU per hour attaining —75° in 1½ hours. . . . On the —90° unit an approximate extraction of 100 BTU per hour reaching rated temperature in 2 hours.

Let Kold-Hold engineers help you determine which capacity and temperature is best suited to your cold processing application.

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point for electrical connections is the fact that electrical conductivity of solder is only about 1/10th that of copper. For these reasons, there is a tendency to use silver solders for electrical joints where possible.

Copper brazing is carried out at such a high temperature that it may damage the structure of alloy steels; generally the grain structure can be restored to normal by suitable subsequent heat treatment. High carbon steels will tend to decarburize during the copper brazing.

Stainless steel and the nickel chromium alloys can be successfully brazed only in a perfectly dry gas, such as is obtained from cracked ammonia. In the case of spot welding, the smallest space allowable for a good spot weld is twice the weld diameter.

Another spot welding trouble is due to inaccessible positions requiring crooked electrodes difficult to water cool and to maintain to size and shape. The minimum distance between centers of welds should be three times the weld diameter, and the distance from the edge of the sheet to the center of the weld should not be less than 1½ times the weld diameter.

If the minimum width of a spot welded flange is not at least twice the weld diameter, projection welding or copper brazing should be considered. Projection welding can be used on sheets as thin as 0.02 in. The upper limits of sheet thickness will depend on the capacity of the welding machine. However, it is being used for sheets as thick as 0.25 in.

Where production on a large scale is contemplated, the designer should have accurate and unbiased information as to alternative methods. If possible, such alternative methods should be tried and subjected to destructive tests.

—J. L. Miller, *Sheet Metal Inds.*, Vol. 18, Nov. 1943, pp. 1971-1979

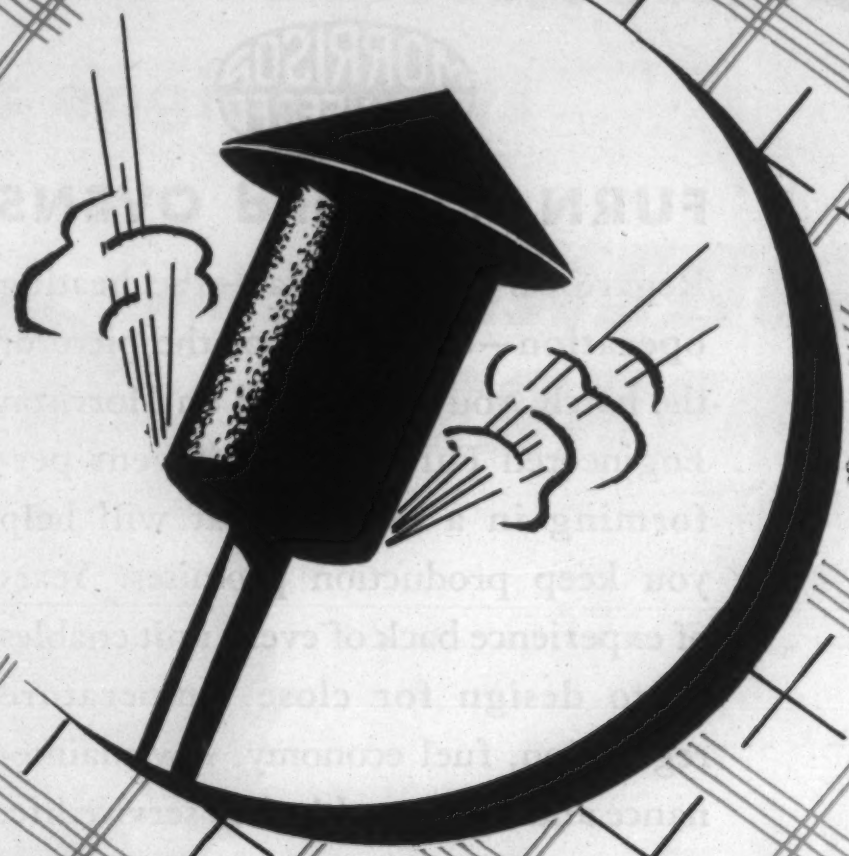
Orientation in Deep-Drawing Steel

Condensed from "Metals Technology"

Preferred orientation, in deep-drawing operations, is undesirable because it necessitates trimming operations and increases scrap loss, and because oriented metals crack more easily than randomly oriented material. However, in the electrical industry preferentially oriented silicon irons are in demand for transformer applications because of the improved magnetic permeabilities in the rolling direction.

Magnetic torque measurements on ferromagnetic materials provide a simple and rapid method of evaluating orientation. It is only necessary to punch or machine a 1 in. disk of the sheet material and insert it in the testing device. The method is a convenient tool for following changes in orientation due to rolling and heat-treating.

In following the phenomenon of orientation in low-carbon steel by this method, changes were observed on steel that had received two preliminary treatments before cold-rolling. One portion was recrystallized for 10 hrs. at 700° C. (1290° F.).



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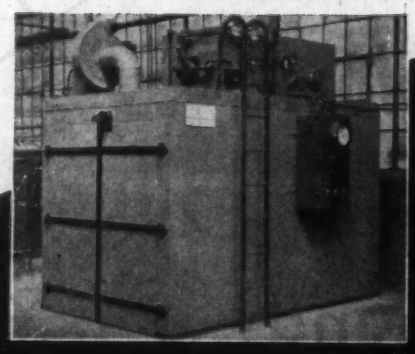
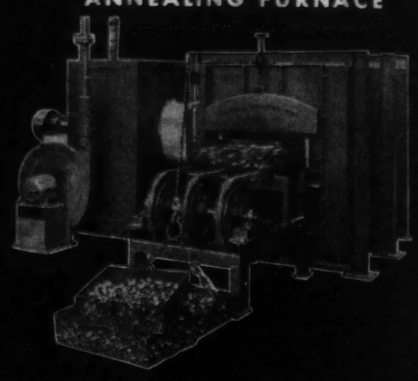
Regardless of the metal—the heating operation—or the size of the piece or the batch, you can depend on Morrison Engineered Furnaces and Ovens performing in a manner that will help you keep production promises. Years of experience back of every unit enables us to design for close temperature regulation, fuel economy, low maintenance and long trouble-free service life.

Morrison engineers are at your service. Talk with them before buying your next furnace, oven, rod baker or metal-coating equipment.

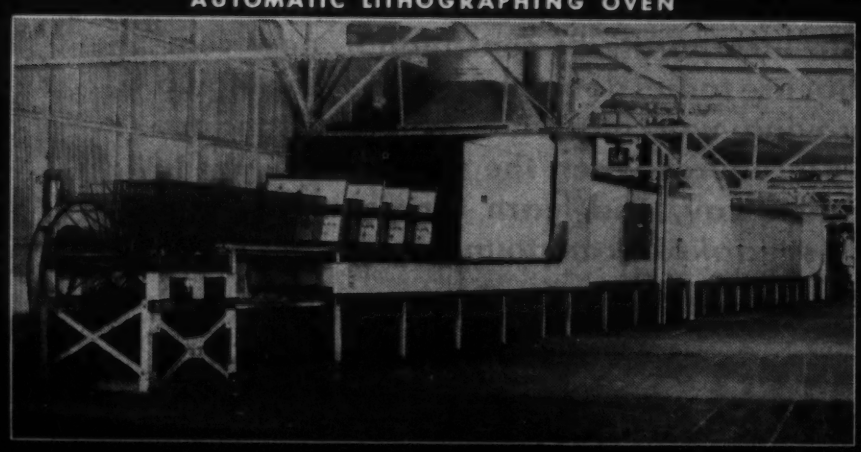


BOX TYPE OVEN

CONTINUOUS ANNEALING FURNACE



AUTOMATIC LITHOGRAPHING OVEN



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Another was heated to 980° and 1000° C. (1790 and 1830° F.) above the critical temperature and furnace cooled. Some as-received material was cold-rolled with no treatment. The development of the recrystallized orientation by annealing the cold-rolled material was studied after annealing for various times at different temperatures.

A linear relationship was found between the degree of orientation and the logarithm of the ratio of the final to the initial thickness. In the recrystallization of the cold-worked material, a maximum in the degree of preferred orientation was found in the region 65 to 75% reduction, when the cold-rolled strip was recrystallized at 600° and 850° C. (1110 and 1560° F.). Prolonged annealing (up to 50 hr.) at 600° C. does not result in any improvement, but at 850° C. it increases the degree of orientation.

Preferred orientation, either in cold-rolled or recrystallized material, can be destroyed by heating above the critical range, but complete random orientation does not occur unless the material has been cold-worked a minimum of 40%, or has a recrystallized preferred orientation.

—James K. Stanley, *Metals Technology*, Vol. 10, Sept. 1943, Tech. Pub. No. 1635.

Welded Bomb Casings

Condensed from "Ceramic Industries"

Prior to the war, the Eljer Co. manufactured enameled fixtures. On July 29, 1942, hardly more than a month after the last enameled fixture was made, the first finished casing for a 1,000-lb. bomb was shipped.

Starting with two forgings of the upper and lower portions of an aerial bomb, the casing is welded so perfectly that the internal pressure before the explosion can reach almost unbelievable intensities. The inside surface must be free from abrasive points.

The first job is to scarf the forgings and fit them together perfectly, so the overall length of the bomb will be standard. When the two parts are fitted together, the joint is tack welded and checked for length. The first pass of girth welding, after preheating, is made by hand; then automatic welding, carefully controlled, takes place. Next the carrying lugs are welded in place. Normalizing of the bomb casings is done in gas-fired furnaces. A definite time is allotted to heating, soaking and cooling.

Hydrostatic testing of the casing involves the use of special equipment. The water must completely replace air to avoid explosions; water pressure is gradually stepped up to the designated pressure. Grinding is done before normalizing, but it is a preliminary operation to shot blasting. Rough spots of the interior and exterior are ground down to surface levels.

The interior painting must be done with special care. The paint applied must be of proper thickness and uniformity. Thorough inspection of all parts and operations is important.

—*Ceram. Inds.*, Vol. 41, Nov. 1943, pp. 34-37.

PRATT & WHITNEY AIRCRAFT

cleans engine parts

with PENNSALT CLEANER K-7

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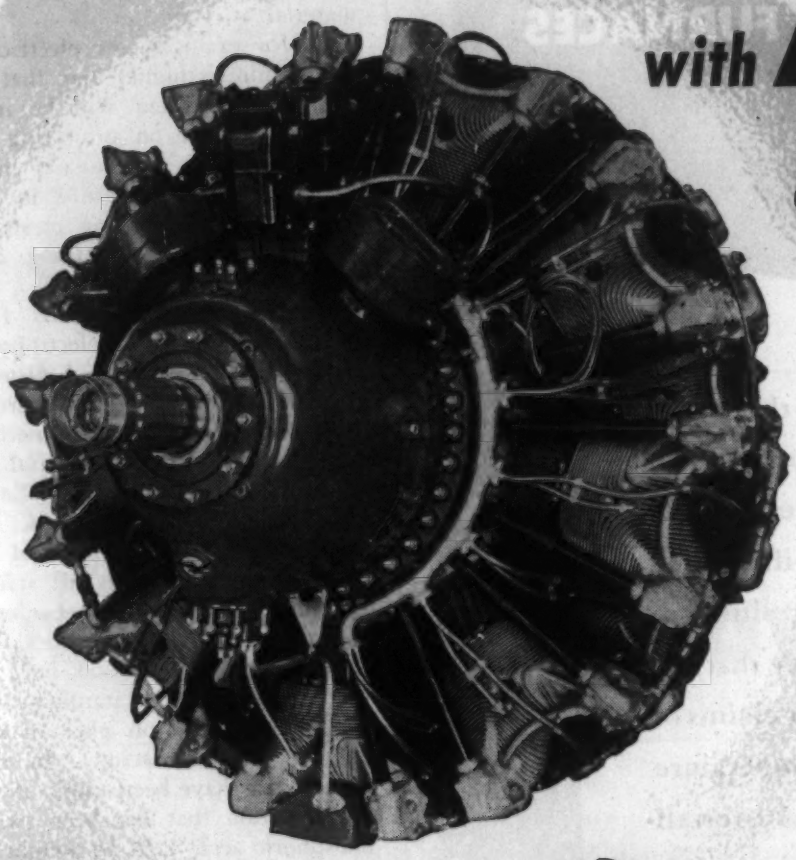

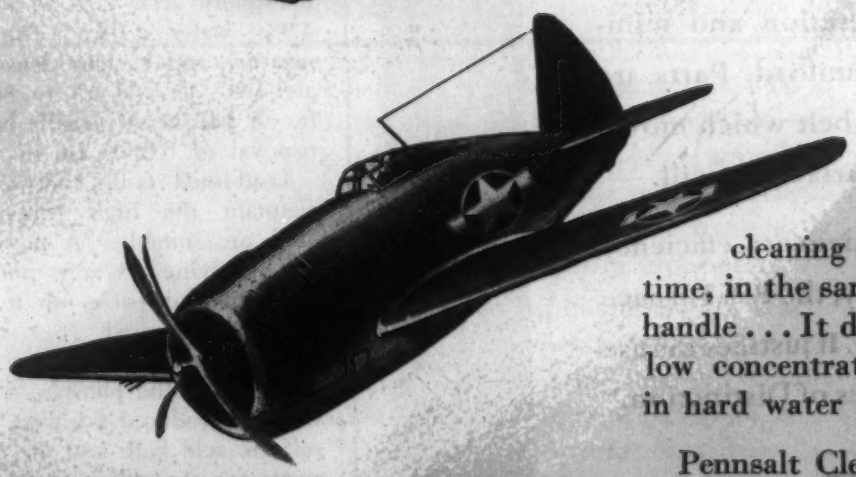

in the Bullard-Dunn Process

An important metal cleaning job in this plant is the removal of scale and oil from Pratt & Whitney aircraft engine parts. Pennsalt Cleaner K-7 was demonstrated in the Bullard-Dunn Process with highly satisfactory results, at a concentration of only 10 ounces per gallon.

Here are the outstanding advantages of this Pennsalt Cleaner: It does *not* leave a film . . . Both cleaning and defilming are done in minimum time, in the same tank . . . Pennsalt K-7 is easy to handle . . . It does not fume . . . It can be used at low concentrations . . . And it is suitable for use in hard water areas.

Pennsalt Cleaner K-7 was designed specifically for the cleaning and defilming operations in the Bullard-Dunn Process and has been thoroughly tested and approved by The Bullard Company.

Pennsalt Cleaner K-7 is one of a complete line of Pennsalt Cleaners available for all types of metal cleaning. If you have a wartime metal cleaning job, by all means make use of the wide experience of our technicians. No obligation. Simply write fully about your problem to our Pennsalt Cleaner Division, Dept. MA.

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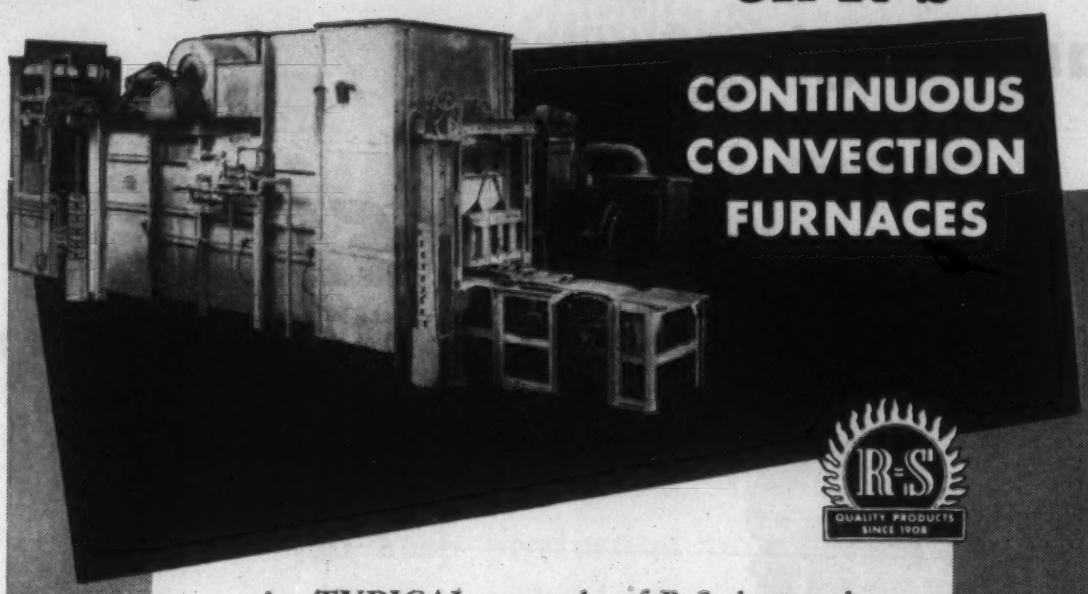

A TYPICAL example of R-S thoroughness in adapting a type of furnace to a particular heat-treating job is the continuous convection, gas-fired furnace illustrated above. Frankly, we are not permitted to divulge full details. Suffice it to say that the production results substantiate our claims of exceptionally uniform and close temperature control (400 to 1300°F.), general over-all efficiency, automatic operation and minimum labor to load and unload. Parts are loaded on the wire mesh belt which moves at a constant, set speed, variable at will.

From the viewpoints of delivery, efficiency in operation and reliability, the R-S Furnace record is truly outstanding. It justifies the use of the expression "Furnaces of Distinction."

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Electrolytic Polishing of Metals

Condensed from
"J. Electrodepositors' Technical Society"

It has been found that when a metal is made anodic in a suitable electrolyte under proper conditions of current density and temperature, the surface will acquire a reflective finish. The explanation suggested for the polishing effect assumes that the soluble salt of the anode metal, which is formed adjacent to the electrode, interferes with continuous solution of anode material.

If, for example, the electrical resistance of this film is higher than that of the electrolyte, the current will be impeded and will concentrate on projecting portions of the anode that lie outside the impeding layer. This action results in selective solution of the projecting crests, thus leading to a gradual smoothing or polishing of the surface.

For preparing specimens for metallographic examination, electropolishing can be done more easily and faster than mechanical polishing, the distortion of the surface that results from mechanical polishing is avoided. Industrial application of electropolishing has been limited to the polishing of stainless steel, nickel and aluminum, with stainless steel the largest application. Practically all stainless steels are tough; as a result, mechanical polishing is expensive.

Two types of solution have been used for electropolishing stainless steel industrially, one based on phosphoric acid and one on sulfuric acid. In some cases mixed acids have been used. A phosphoric acid solution that has been used contains phosphoric acid, 42% by weight; glycerine, 47%; water, 11%. The optimum temperature and current density, respectively, are 100° C. and 15 to 80 amp. per sq. ft. A polish can usually be obtained with removal of 0.0005 in. of metal.

Lead-lined tanks, adequately lagged to maintain the high temperatures usually used, are suitable. A power supply capable of giving 15 volts and with capacity for current densities up to 200 amp. per sq. ft. is required.

Experiments carried out by the author showed that the phosphoric acid bath consistently produced a higher polish than the sulfuric acid bath and the current requirements for the sulfuric acid bath were less exacting.

The smoother the surface before it is electropolished the better the results will be. Curved surfaces, and small articles such as trays, door handles, knobs, etc., lend themselves well to electropolishing. Large flat surfaces are difficult to polish, largely due to the fact that it is difficult to obtain a uniform current density on all parts of such a surface.

Some work has been done on the electropolishing of nickel. The solution favored by Hothersall and Hammond contains 73% by weight sulfuric acid. It is operated at a current density of 250 amp. per sq. ft. and a temperature of 30° C. Polishing time is 0.5 to 5 min. For plant purposes, rubber or lead-lined tanks fitted with a moving anode rod and cooling coils are suggested.

In order to obtain a high degree of pol-

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These furnaces may be oil fired, gas fired, or electrically heated. We build them in five standard sizes with capacities ranging from 300 to 1700 pounds per hour. Larger or smaller sizes can also be furnished if required. Any size can be designed for using the special protective atmospheres for scale free heat treating or hardening without decarburization.

The Chain Belt Conveyor Furnace is only one of the numerous types of production furnaces we build. Other recent installations include furnaces for bright annealing both ferrous and non-ferrous strip, wire, tubing and other products . . . furnaces for the production heat treatment of tank armor castings, cartridge cases, shell forgings, bomb and gun parts, machine gun cartridge clips, aircraft and aircraft engine parts, aluminum and magnesium castings and forgings, and many other products.

The Electric Furnace Co., Salem, Ohio

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ish on a nickel surface the basis metal should be buffed. Two difficulties that sometimes occur are pitting and streaking. Where the nickel deposit is initially 0.001 in. thick, the porosity is not seriously increased by electropolishing.

The British process for electropolishing aluminum (known as Brytal) makes use of an alkaline bath. The reflectivity of polished commercial aluminum is increased from 73% to 77% with this process, while a reflectivity as high as 84% has been obtained with super-purity metal.

The articles to be treated should be well-polished first and free of surface defects, such as inclusions and rolling marks. The solution contains sodium carbonate and trisodium phosphate. It is operated at temperatures of 165 to 190° F. and initial current densities of 50 to 60 amp. per sq. ft., this being reduced after a short time to 25 amp. per sq. ft. The time required is 5 to 8 min.

The work is removed and rinsed, and the high finish is then protected by the following treatment: (1) Anodize in a sodium bisulfate solution at 6 to 8 amps. per sq. ft. for 20 to 30 min.; (2) rinse and soak 15 to 20 min. in hot distilled water; (3) dip in 10% sulfuric acid; (4) rinse in cold water and hot water; and (5) dry and wax.

Despite some difficulty with maintaining the electropolishing solution, the process is being increasingly used, particularly for lamp reflectors.

—S. Wernick, *J. Electrodepositors' Tech. Soc.*, Vol. 18, 1943, pp. 103-120

Making Drop Hammer Dies

Condensed from "Aero Digest"

Drop hammer dies for prototype and sample parts, adapted just now to the aircraft field, are being made by novel methods by the Castaloy Corp. of California, Los Angeles.

Starting out with master models made of mahogany, steel or plastic, a plaster model is made. Then, around the plaster model is poured Cerrobend, which remains molten at such low temperatures that it can be pumped through a long rubber hose. When this metal has finally cooled and hardened, a final coating of harder metal is sprayed upon the surface.

From the resulting die aluminum, steel and plastic parts can be made in quantities from 1 to 50.

Not only is a die for stamping out parts produced, but also a set of checking fixtures. The plaster patterns are placed in a large tank, containing a circulating liquid, it taking the Cerrobend metal just 45 min. to cool. This alloy does not shrink, hence eliminating machining, etc.

Anchor lugs and cores for holding the die in the drop hammer are mounted and cast in place during the pouring of the Cerrobend.

—Harvey G. Groehn, *Aero Digest*, Vol. 43, Nov. 1943, pp. 229, 231.

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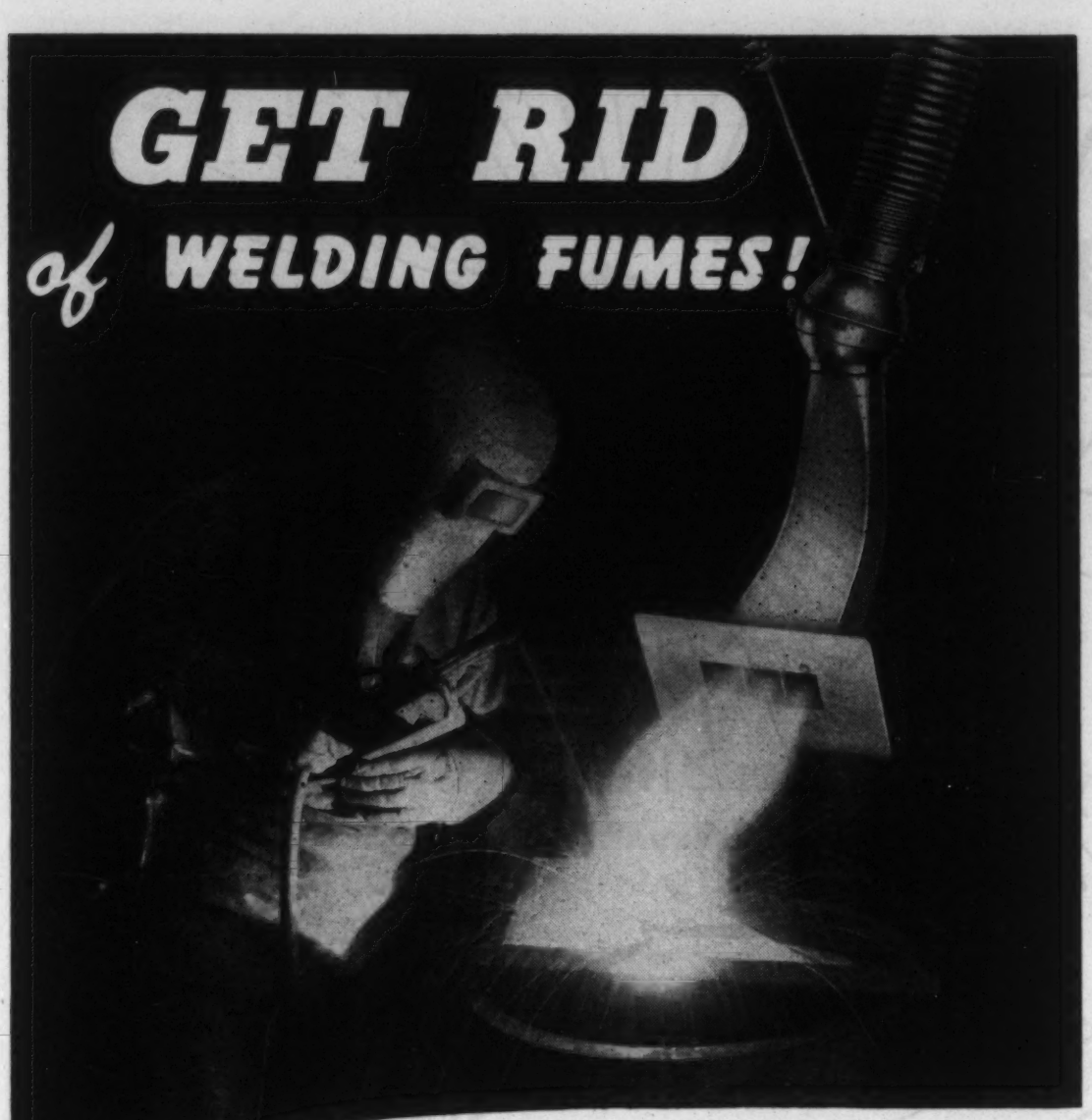

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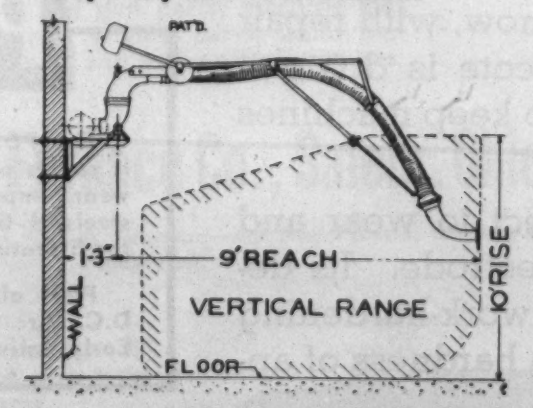

Arm extended for maximum reach. Note unusually wide working range.

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Drawing Chrome-Molybdenum Steel

Condensed from "Steel"

The deep drawing of hot-rolled chromium-molybdenum steel, never considered well adapted for this purpose, has been mastered by Walter Kidde & Co., New York, in the large-scale production of high-pressure cylinders for carbon dioxide and oxygen.

The company until recently machined the cylinders from heavy chromium-molybdenum forgings, which it purchased. The forgings were bored inside and turned outside to specified wall thickness; the open end was then necked down by hot-hammer forging, following which it was necessary to machine the cylinders at the neck to remove excess metal, because use in aviation demanded minimum weight yet maximum strength.

For each 10 lbs. of steel in the final cylinder, the old process required 45 lbs. of steel in the form of forgings. Thus, some 35 lbs. were machined away as scrap.

With the new process, for each 10 lbs. of steel in the final cylinder, there is required only about 16 lbs. of steel sheet, reducing the scrap to about one-sixth of that necessary under the old process, boosting production some 10 times. The new type of cylinder now being produced is made shatterproof by a closely wound covering of piano wire.

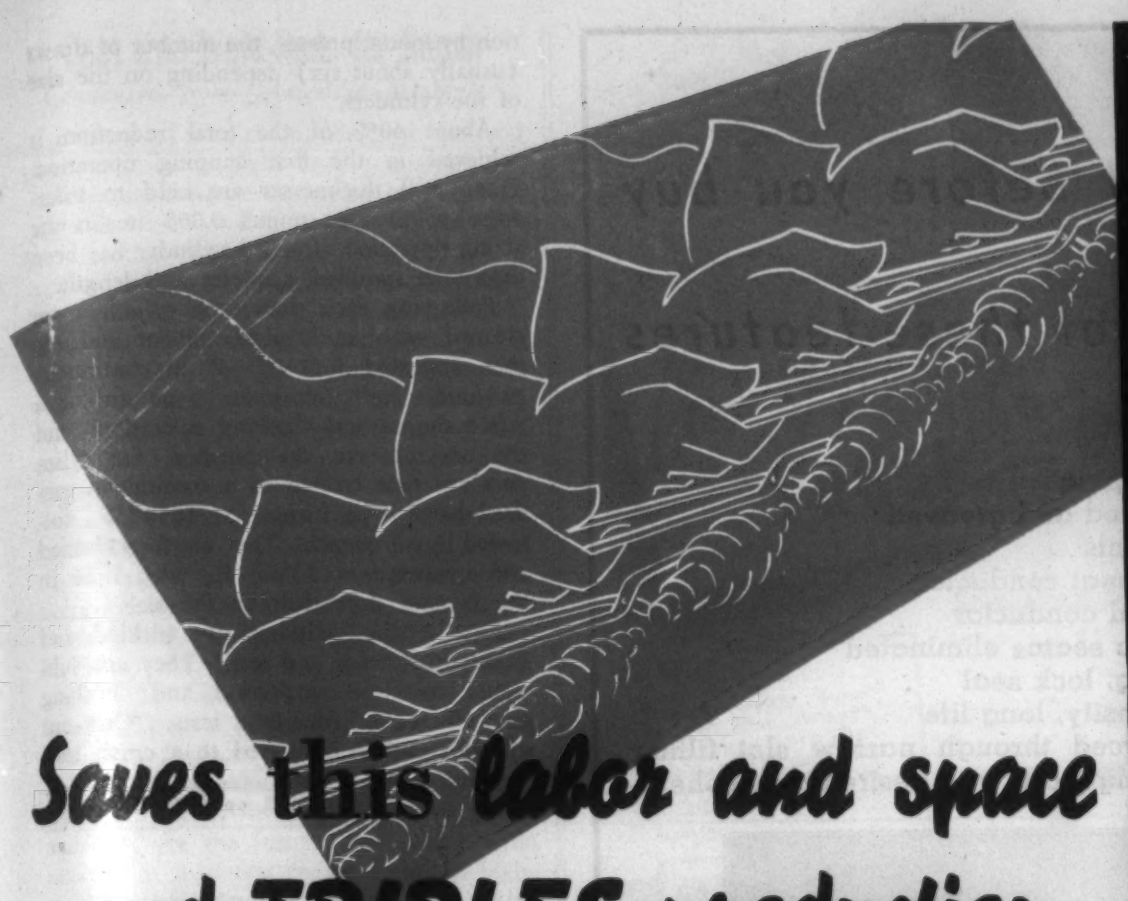
Conversion to the deep-drawing process made it necessary to lick several problems. The deep-drawing of ordinary low-carbon steels is comparatively simple. The tough chromium-molybdenum steels are not normally considered of deep-drawing quality. The use of such a steel was necessary to meet strength, weight and dimensional requirements.

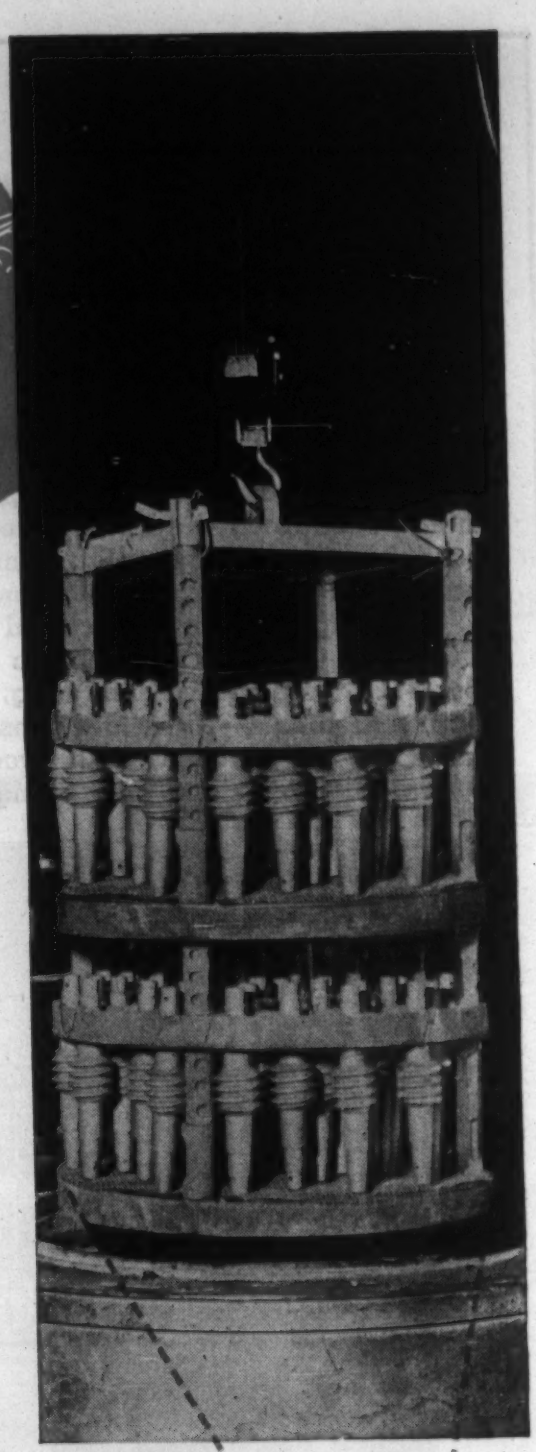
In working out the manufacturing procedure, which principally involves drawing, cleaning, annealing and heat treating, along with a minimum amount of machining, punches and dies proved to be one of the most difficult problems. High-carbon or commercial punch and die steels worked well in blanking out circles, but when it came to the drawing operations, it was necessary to introduce special methods and experiment with various types of steels, especially to reduce die wear and metal pickup.

High-carbon and high-chromium steels were formerly used for punches and drawing dies. Later it was found that graphitic punch and die steels worked well all along the line, and they are now being used in considerable quantities. Carbide drawing dies have also proved advantageous, especially for the last two or three draws, but their use is limited since they cannot be made in large diameters.

Large sizes of punches and dies that are required render heat treating difficult. It is now the practice to harden all types in automotic controlled-atmosphere furnaces, followed by an oil quench for the graphitic steels and a water quench for the others.

The company buys SAE X4130 steel in flat sheets for the cylinders. Circles are blanked out on a 500-ton single-action, double-crank mechanical press. All subsequent cupping and drawing operations are performed on double- and single-ac-





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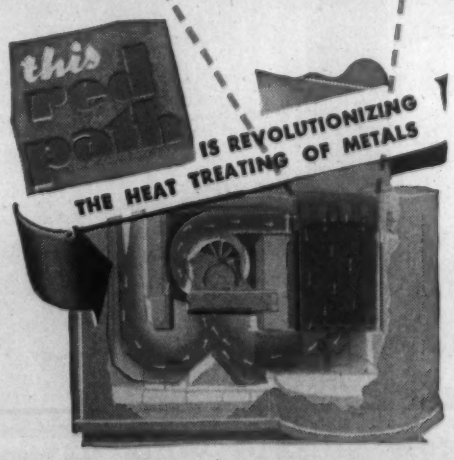

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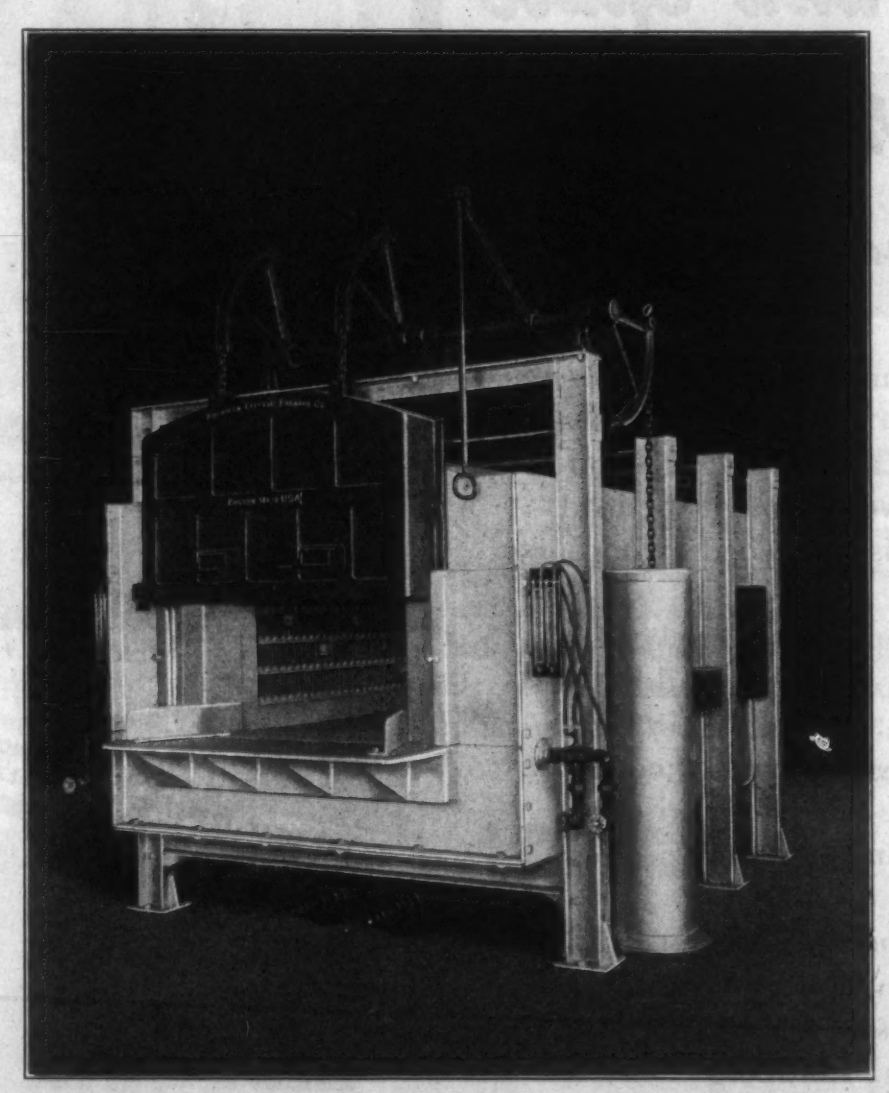

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tion hydraulic presses, the number of draws (usually about six) depending on the size of the cylinders.

About 40% of the total reduction is achieved in the first cupping operation. Final wall thicknesses are held to tolerances of plus or minus 0.005 in. in the sizing operation after the cylinder has been drawn to specified diameter and length.

Following each draw, the cylinders are cleaned with a chemical solvent and are then annealed at 1300° F. in continuous gas-fired, inert-atmosphere type furnaces. After the several drawing operations and the necking, etc. are finished, the cylinders are heat treated in a continuous gas-fired batch type furnace at 1550° F., followed by oil quench. They are then cleaned and tempered at 1250° F., with time in the furnace dependent on the size.

Finally, the cylinders are pickled and Parkerized inside and out. They are subjected to close inspection and checking as well as to hydrostatic tests. One out of every 200 is subjected to a crush test.

—Irwin H. Such, *Steel*, Vol. 113, Nov. 1, 1943, pp. 90-91, 124, 126.

Bright Gas Quenching

Condensed from an American Society for Metals Paper

Welded steel tubing of SAE X-4130 can be normalized to produce the properties required in AN-T-3 specifications only when treated on a small scale. Normalizing in large production continuous heat treating furnaces produces the required properties in only a few instances. However, bright gas quenching in a super-fast cooling zone enables these properties to be met on a large production scale.

The use of a bright gas rather than air gives a faster cooling rate and eliminates the formation of scale. The physical properties are controlled by the rate of gas recirculation, by the conveyor speed and by the temperature from which the tubes are gas quenched.

The proper adjustment of these variables is dependent on the carbon content of the steel and the thickness of the tubes. For example, heavy wall tubes are quenched from 1700°F.; light and medium tubes, from 1650° F. The effect of carbon content is such that the lower the carbon, the more drastic must be the gas quench; that is, the greater must be the rate of gas recirculation.

The bright gas quenching of welded X-4130 aircraft tubes is usually followed by an aging treatment (at 800°F. in a separate furnace). This accelerated aging increases the yield strength by more than 10,000 psi, decreases the tensile strength by more than 10,000 psi, and decreases the elongation by an average of 5%.

For all practical purposes, NE 8630 is capable of developing the same physical properties upon gas quenching as the SAE X-4130, and the heat treatment involved in gas quenching and in aging is identical for both types.

—W. Lehrer. A. S. M. Preprint No. 22, Oct. 1943 meeting, 31 pp.

(Continued on page 429)

Cast Iron Weld-Rods for Repair

Condensed from "American Machinist"

Because of war conditions, cast iron rod is often used to weld broken castings. It is also used where the color of a bronze weld is objectionable or the welded part is subjected to high temperatures.

For fusion welding, cast iron parts must be preheated to between 600 and 1,300° F. The lower temperature is used when the location of the break allows freedoms for expansion and contraction. Overheating causes parts to sag or warp. A flux and rod made especially for cast iron must be used.

As most welded cast iron parts must be machined, they should be welded immediately when the preheat temperature has been attained and allowed to cool slowly in the furnace. For a weld of maximum hardness, the part may be heated after welding to 1,600° F. and cooled rapidly in air. There must be no direct drafts.

Preheat furnaces for small parts may be built on heavy metal tables or on the floor using steel plate over sand, or fire bricks and sand for the furnace bed. The walls must be at least one course of bricks higher than the supported casting. Air spaces must be left in the lowest course. Charcoal or gas is usually used for fuel. With the latter baffles must be built to prevent direct contact between flame and casting.

The top of the furnace should be covered with sheet asbestos or its equivalent. When the welding is completed, the top of the furnace should be completely covered and damper bricks placed in the air spaces.

If a casting is too large to be moved to the welding shop, a preheating furnace can often be built around it. Some small castings can be preheated with the blowpipe. After welding, the casting should be preheated to a good red heat, placed in an annealing bin containing asbestos wool and allowed to cool slowly.

Methods of Welding

Before welding, the break should be veed to an angle of 45°, running the bevel to within ⅛ in. of the bottom. The blowpipe is used with a circular motion. When the metal becomes soft and appears wet, flux should be applied with a cast iron welding rod, not thrown in. Alternate additions of the rod and fusion of the weld should be done with rhythmic timing.

Excess oxide on the puddle can be removed with the end of the welding rod. When white specks, also oxides, appear, flux should be added. If left in the weld they will cause hard spots. Manipulating the inner cone of the blowpipe flame in the puddle will bring them to the surface. Gas bubbles that form blowholes may be removed in the same way.

Fractured casting lugs often have to be repaired. If the broken piece is lost, it is better to rebuild by welding in a vertical position. The built-up portion is made somewhat wider than required, and after it is built up to length, excess metal is removed from the sides by heating it with a blow pipe and removing it with a file.

When broken cast iron parts have one or more bearings that must be kept in alignment, the parts may be blocked up on

Case History* PROOF

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Aircraft Parts Manufacturer. Reports that extensive tests on various brazing operations prove Scaiflux 21 most satisfactory on all counts.

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The war production program called for heat resistant containers and other parts in unprecedented quantities. To meet these requirements for urgently needed chromium-nickel alloy castings, we have greatly increased our Amsco Alloy production.

Amsco Alloy is made in a variety of analyses, to meet the requirements of the entire range of applications which call for maximum resistance to heat and corrosion. Their proper application minimizes replacements and conserves less suitable metals for other uses — therefore, Amsco Alloy has a dual war-time role: serving and saving.

The pictures show a few representative applications:

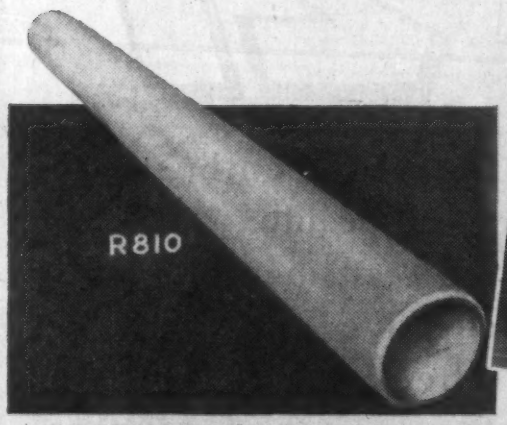
R-810—One of a great many Amsco Alloy F-1N retorts made for producers of magnesium metal used for incendiary bombs and aircraft parts. Each retort weighs 1,100 lbs. A cap is welded on one end.

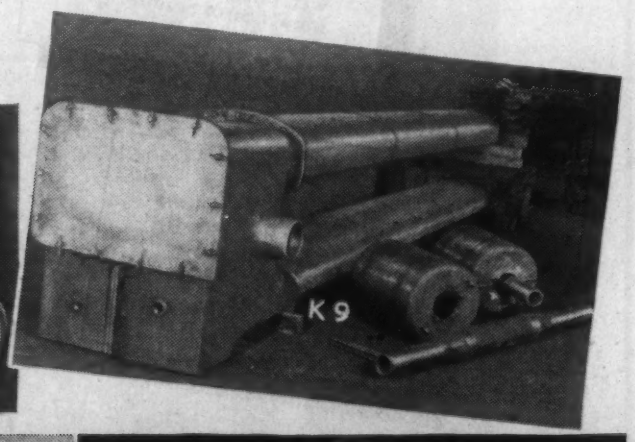
K-9—One of 11 Amsco Alloy F-1 and F-10 assemblies for gas-fired controlled atmosphere muffle type furnaces for heat-treating machine gun clips. Muffles are 20′ long, cast in three sections, butt-welded together and bolted to discharge housing by flanges.

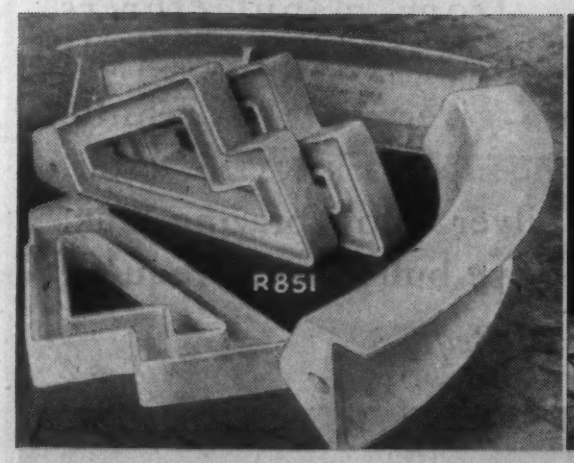
R-851—Amsco Alloy F-10 frame castings for rotary type furnace, consisting of guides weighing 71 lbs. each and supports, 53 lbs. each.

R-875—Besides speeding production of needed parts, these Amsco-Johnson reversible tray assemblies (U. S. Patent 2,303,882) conserve metal three ways: (1) Made of Amsco Alloy F-1; (2) Rails cast separately eliminate heating and cooling stresses that result when rails are cast integral because of heavier metal section where rail joins tray; and (3) Rails can be removed by torch-cutting holding pins, permitting trays to be "flopped over" to compensate for warpage.

Ask for Bulletin 1041-A covering Amsco Alloy Heat Treating Containers, Retorts and Furnace Fixtures.







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a welding bench with one side of the break in a flat position. Half the break is melted out and tack welded. When this has set, the part is turned over and the other side welded. This is repeated until the job is completed. As these welds have little strength, the casting must be handled carefully.

Sometimes it is cheaper to use a new casting than to weld the broken one with cast iron rod. Some concerns are saving broken castings until a time when bronze rods will be available.

—Arthur Havens, *Am. Machinist*, Vol. 87, Oct. 14, 1943, pp. 108-110.

How Zinc Protects Steel

Condensed from
"Engineering News-Record"

Metal protective paints containing zinc pigments function by providing a mechanical barrier to corrosive atmospheres, and by inhibiting corrosion at breaks in the paint film. No paint film is sufficiently perfect or permanent to insure complete, continuous protection. All paint films undergo aging, which is accompanied in many cases by formation of corrosion products within the film. By use of proper corrosion inhibitive pigments, this effect can be controlled automatically.

A pigment containing 80% zinc dust and 20% zinc oxide has found the widest acceptance. It has excellent protective qualities, even on partially rusted surfaces, is non-toxic, and adheres well to galvanized and other zinc surfaces. The zinc dust imparts film distensibility, abrasion resistance, and adhesion to the film, but its rust inhibitive property is of greater importance.

The zinc oxide compensates for the settling tendency of the zinc dust; facilitates the formation of firm, uniformly dried paint coatings, which have abrasion and water resistance; contributes inhibitive action; and counteracts undesirable acid conditions developed upon weathering.

For a cheaper paint a mixture of 50% zinc dust, 20% zinc oxide, and 30% natural red iron oxide in linseed oil is an excellent, high hiding, general maintenance red paint. It gives good service in acid atmospheres, but is not desirable for galvanized or other zinc surfaces. Synthetic resin vehicles can be used with this pigment where fast drying and under-water use are major considerations. Other iron oxides may be added to the combination of zinc dust and zinc oxide.

Iron oxide paint protects essentially by mechanical means. Adding zinc oxide improves the protective and other qualities. A useful combination is 80-85% iron oxide and 15-20% zinc oxide.

Zinc chromate primers are used extensively for ships, because of their excellent rust inhibiting action in under-water service. They require almost exclusively synthetic resin vehicles. Cheaper pigments, such as iron oxide or inerts, may be added.

Zinc tetroxy chromate has been developed for use with linseed oil vehicles

How to *prevent* Corrosion

Coat a section of any piece of raw metal with a protective film of Anti-Corrode. Place it out-of-doors, and leave exposed to the elements.

Rain, snow, changing temperature, dust and grime have eaten into and oxidized the unprotected metal. But note surface under Anti-Corrode film—bright and unharmed, in its original state.

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40 years continuous service—growing with the metal processing industries —has brought Pangborn engineers into intimate contact with almost every possible blast cleaning and dust control problem. To this rich background of experience is added more than two years of successful designing, building and erecting of specialized war plant installations — both ROTOBLAST and Air Blast. The Army-Navy "E" award, with added star, proves the value of this equipment in the vital war effort. Qualified beyond question to recommend only the most efficient equipment—Pangborn asks specifically for an opportunity to work with you—at once—

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to make general maintenance primers. These are light weight, and can be sprayed easily. The zinc tetroxy chromate has excellent rust inhibitive properties, and contributes to the formation of firm, water-resistant films. A combination of 65% zinc tetroxy chromate and 35% red iron oxide is suggested.

—F. C. Schmutz & G. W. Ashman, *Eng. News-Record*, Vol. 131, Nov. 4, 1943, pp. 682-686.

Cold Treatment of Metals

Condensed from "Machine Design"

Major industrial applications of refrigerating equipment may be grouped into four classifications: stratosphere test chambers, metallurgical treatment, fabrication methods, and chemical processes.

Makers of gage blocks have been using the cold process for 20 years, one procedure having been repetitive quenching from boiling water to iced brine with perhaps 50 to 100 cycles required. With improved and lower temperature mechanical refrigeration, however, the number of cycles is reduced greatly. Marked improvements in hardness and ductility on high-speed steels by direct immersion in liquid nitrogen (minus 310° F.) before tempering and immediately following the quench have been produced experimentally.

Formerly, aging of steel for gage blocks required a span of a few years, but this can be speeded greatly by refrigeration. One maker hardens and grinds gage blocks within 0.002 in., then holds the blocks for 10 hrs. at minus 50° F. Reaching room temperature, they are immersed in oil, gradually raised to 200°, soaking for 4 hrs. Then they are cooled to room temperature, with more minus 50° for 10 hrs.

Practice is not standard, however. One maker puts his gage blocks through six cycles, cooling down to minus 120°, the final stabilization eliminating metal growth and warp.

Another application is in the case of a cylindrical way for a machine tool, SAE 4615 steel, whereby the manufacturer gets a Rockwell C hardness of 60 to 62 instead of the normal 57 to 60, by treatment down to minus 120°. Nor is there any distortion, such as occurred in normalizing used previously.

Another use of subzero temperature is in retarding the age hardening of aluminum rivets and sheets for forming, particularly the 17 S-T and 24 S-T alloys. Rivets are usually stored at temperatures from zero to minus 45° F. immediately following cold quenching, and may be held up to 10 days without appreciable hardening. A manufacturer who forms and stretches aluminum alloy sheets, 17 S and 24 S, places them in a refrigerator at 32° within 5 min. after heat treatment, and they may be held for 24 hrs.

After removal from the refrigerator, the 17 S must be worked within 30 min.; the

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The stirring battle record of Lockheed P-38 Lightnings needs no embellishment. They have proved they can take it and dish it out with interest.

Many factors, of course, contribute to their fine record, but underlying them all is *sound construction* in every part.

Above you see a vital part—the radiator. It is produced mainly by EASY-FLO brazed construction. Framework, headers, inlet and outlet connections are fabricated into one reliable unit with this low temperature silver brazing alloy.

On this job, EASY-FLO provides the same strong, virtually indestructible joints, and the same speed, reliability and economy in making them, that have resulted in the amazing spread of EASY-FLO brazed construction in the aircraft field and in so many other fields where metals are joined.

The EASY-FLO story is one which no design engineer and no executive responsible for production can afford to overlook. For, Easy-Flo brazing, with its exceptional speed, reliability and economy, will be as vital in post-war manufacturing as it has proved itself to be in today's war production.

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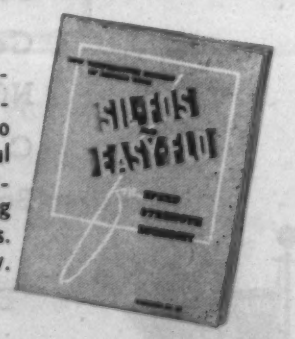

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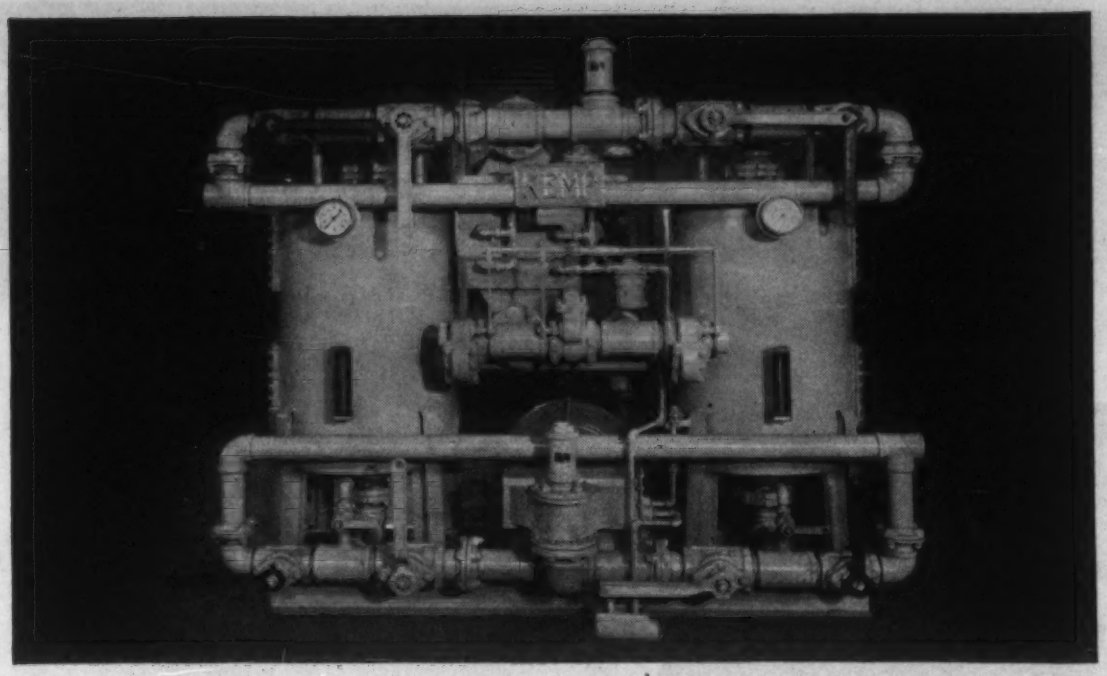

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To paraphrase a famous (and living) U. S. General, standard units may be had RIGHT NOW, special designs will take a little longer. C. M. Kemp Mfg. Co., 405 East Oliver Street, Baltimore-2, Maryland.

***Except the dehydration of foods, which is a different problem altogether.**

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24 S, 60 min. Heat treatment varies between 10 and 60 min. at 910° to 950° F. Material is drawn down to approximate shape on one or two dies, heat treated again and stored in the refrigerator before final forming. In this way wrinkles or spring back are avoided.

Shrink fitting is especially advantageous in a case such as a hub and shaft assembly wherein the shaft is relatively small compared with the mass of the hub. An aircraft maker uses a Deepfreeze chilling unit to fit a plug into a landing strut. The plug, 3.880 in. in diam., is shrunk 0.0026 in. at minus 120° F., while the female part, having a bore of 3.875 in., is subjected to a bath of 450° F. and expanded 0.005 in. The plug is then easily inserted by hand, the entire operation taking 10 min.

The former method of heating the female part with torches was unsatisfactory. Moreover, when assembled on an arbor press scratches resulted, which might later result in failures.

Another maker shrinks a 4½-in. diam. steel tapered roller bearing race 0.003 in. for insertion in a casting. Crankshafts manufactured for Wright cyclone engines utilize four expansion fits in assembly. The shafts have a 2¾ in. diam. steel plug expanded into the center section of the crank arms, shrunk 0.002 in., at minus 35°. Dowel pins are fitted into the center section of the center bearing bracket face; also, counterweight hole plugs are shrunk and fitted.

—John W. Greve, *Machine Design*, Vol. 15, Oct. 194?, pp. 94-98.

Wartime Precious Metal Plating

Condensed from "J. Electrodepositors' Technical Society"

Special war-time applications of precious metal plating are discussed. Examples are silver and silver-indium coatings on metal reflectors, silver on electrical contacts and on high-frequency radio parts. In the latter application, silver is useful because of the phenomenon known as "skin effect."

When an alternating current passes through a conductor, there is a tendency for the current to concentrate near the surface, and the higher the frequency the more marked is the effect. At ultra-high-frequencies, *e.g.*, one hundred million cycles per sec., the current penetrates the conductor only about 0.0003 in. Therefore, a conductor may be made of brass, which is cheap and strong, but has a comparatively high electrical resistance, and then silver plated to a thickness of about 0.0005 in. The electrical performance will then be the same as if the conductor were made of solid silver, which has the lowest electrical resistance of any metal.

Gold is plated over silver to prevent tarnish of radio parts plated with silver for skin effect. Gold is being applied in some instances by cathodic sputtering, *e.g.*, for forming electrodes on non-metallic materials such as porcelain.

Rhodium is being used increasingly on

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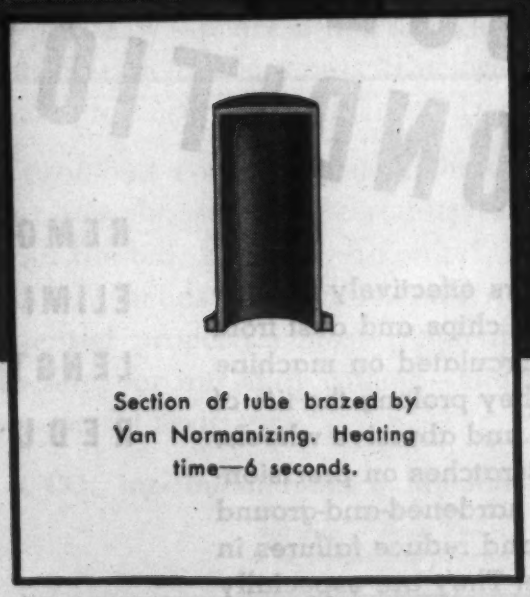

Section of tube brazed by Van Normanizing. Heating time—6 seconds.

In the illustration, collars are brazed to tubes in 6 seconds with Van Norman High Frequency Induction Heating. Bonds are clean, tight and uniform. The finished part has no discoloration and is free from scale, thus cleaning operations, which are usually necessary when torches and other brazing methods are used, are eliminated, spoilage is minimized, and piece after piece is brazed with the same uniform results. Obviously, VAN NORMANIZING produces a better finished part, speeds output and reduces costs.

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It will pay you to investigate Van Norman High Frequency Induction Heating for Hardening, Brazing, Soldering, Annealing and other applications requiring localized heat.

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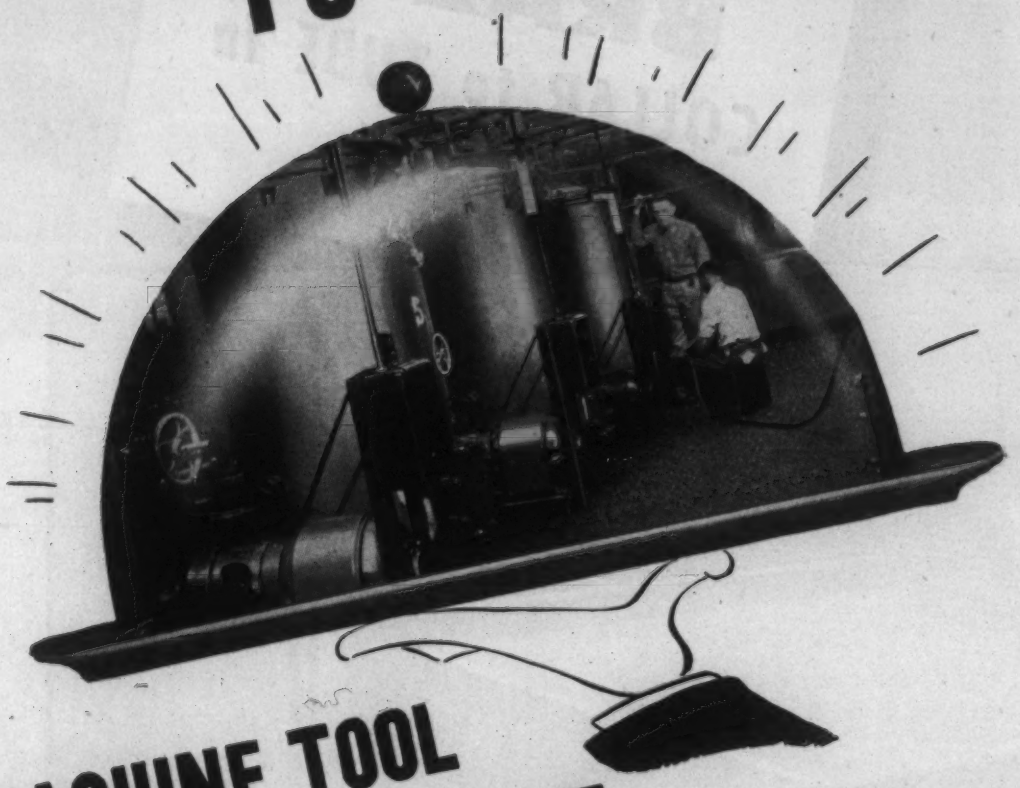

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ELIMINATES SCRATCHES
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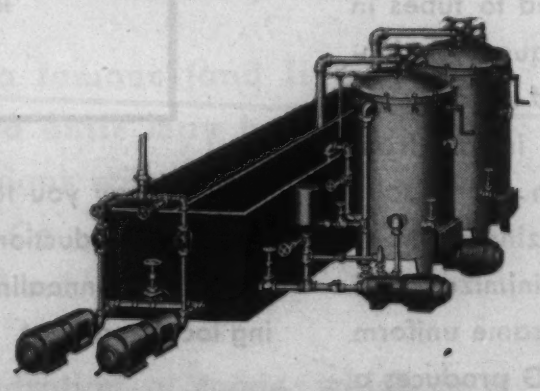

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electrical contacts, and is excellent for this purpose, due to high hardness (Vickers pyramid approx. 800), low electrical resistance, and freedom from any oxide or tarnish film. Where absolute reliability of contacts is essential, electrodeposited rhodium is ideal. Thicknesses up to about 0.001 in. can be deposited.

Rhodium has a high reflectivity, and a thin film of it is often used on mirrors over an undercoat of silver. Platinum may be used for some of the purposes cited for rhodium, but in general it is less satisfactory. Palladium is not much used, since it is quite soft and is less resistant chemically than rhodium or platinum.

—E. H. Laister, *J. Electrodepositors' Tech. Soc.*, Vol. 18, 1943, pp. 69-76.

Cleaning Arc Welded Work

Condensed from "Metal Finishing"

Arc welded machinery is frequently improperly cleaned before painting, with the result that peeling of the paint and corrosion under the paint occurs, particularly on and near the welded joints.

Welded structures may receive a thorough physical cleaning, including wire brushing, chiseling to remove spatter spots, and degreasing, and paint will still fail at the weld as a result of gradual exudation of alkaline compounds contained in the welding electrode and entrapped along the margins of the weld. Therefore, in order for the paint to adhere and give normal protection to areas on and near welded seams, both chemical and physical cleaning is required.

Physical cleaning methods vary with the size and nature of the structure. Slag, dirt, scale and spatter drops of metal may be removed by a power buffer, by wire brushing, or by sand- or grit- blasting. Large slag fragments and spatter drops may still adhere after the above treatments and may be removed by hand chiseling.

A simple washing with water or a solvent will not usually remove the alkaline compounds entrapped in the weld. If pickling is required, the pickling neutralizes the alkaline compounds. If pickling is not used, then the structure should be thoroughly washed with an acidic wash solution.

The best type of wash solution is an acidified solvent, such as naphtha or mineral spirits, but acidified water is effective. Application of the wash solution may be by brushing, wiping or spraying. Spray application is the most effective, convenient and economical method.

Workmen, both operators and inspectors, can be aided in judging when cleaning is sufficiently thorough by means of standard welded cleaning plates. One plate in the set contains an uncleaned weld, one an unsatisfactorily cleaned weld, and one a satisfactorily cleaned weld, which will pass inspection.

Careful inspection of all parts of a unit just before application of the first coat of paint is a profitable investment.

—Walter J. Brooking, *Metal Finishing*, Vol. 41, Oct. 1943, pp. 671-674.

A Ticklish Job...

But Mallory 73 Metal Eliminated the Danger

Mallory 73 metal is a versatile metal that has solved numerous problems where alloys of unusual physical and electrical properties were needed.

In the case of a large manufacturer of explosives, a blade was required to bore a cavity in the powder packed in a shell case. The metal, of course, had to be non-sparking, and yet it had to hold a sharp cutting edge.

Mallory metallurgical experts, when confronted with these essentials, immediately specified Mallory 73 metal. Mallory 73 metal is a copper alloy—hence a non-sparking material. In addition, it offers unusual hardness (Rockwell C-37)—just the requirement to keep the blade keen-edged.

No matter what problems confront you in the selection of non-ferrous alloys, it's almost a dead certainty that Mallory has the metal to fill the bill. Elkaloy*, Elkonite*, Mallory 3, 53B, 53Z, 73 and 100 metals offer, individually, or in combination, the essential properties most frequently sought. You're invited to send for our alloy catalog—and to call on our engineers for special assistance.

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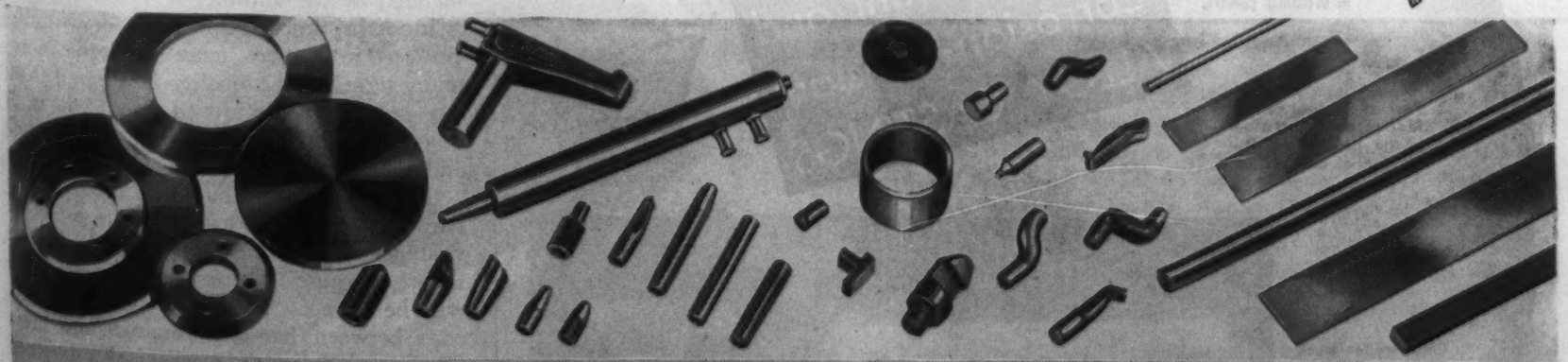

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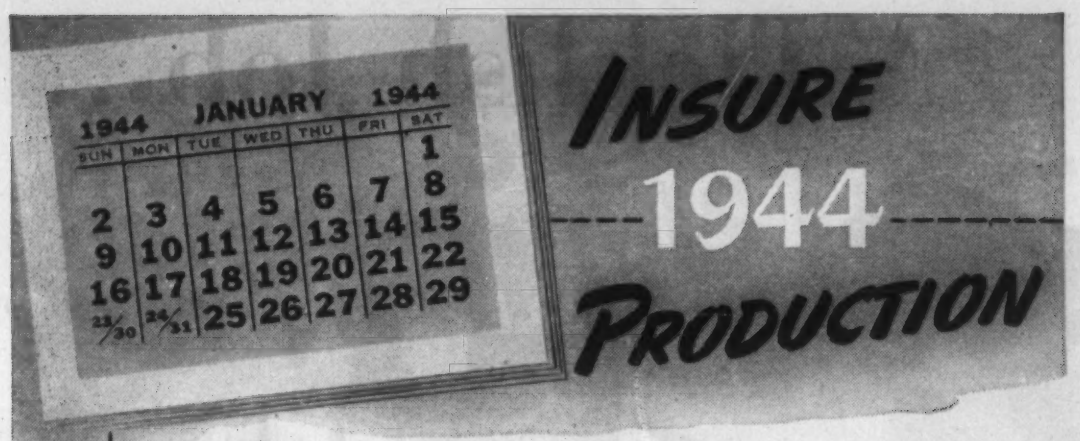

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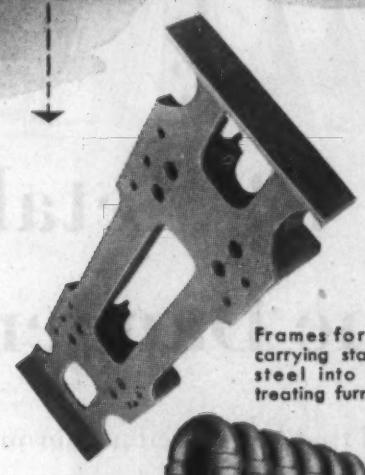
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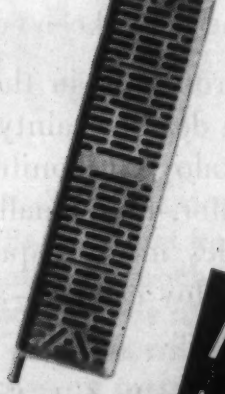
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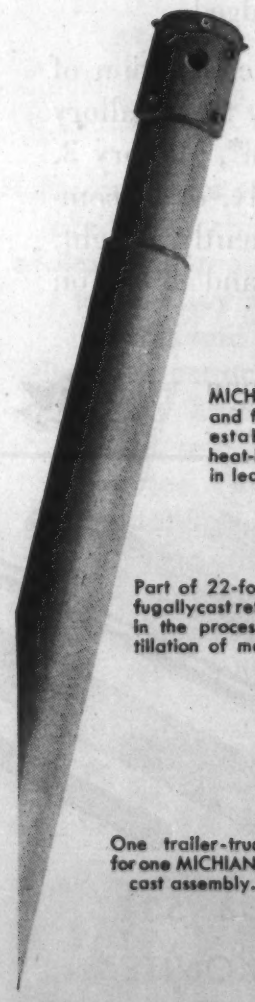
Part of 22-foot centrifugallycast retorts used in the process of distillation of magnesium.

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Aluminum Alloy Press Forgings

Condensed from "Heat Treating and Forging"

Most aluminum forgings are made either on drop hammers or power presses. Hammer forging is one of the oldest metalworking processes. Press forging of aluminum, on the other hand, is a comparatively new technique, stimulated by the demands of the present conflict.

Presses of 700- to 2500-ton capacity are adaptable to fairly simple forgings. Intricate shapes usually go through the same die steps as required in hammer forgings; the only difference is that each step is accomplished in a single operation while hammer forging requires a number of blows.

Dies for small press forging may include the fuller, the edger, the bender, the blocker, and the impression. The rough shaping and drawing out of the metal is done by the fuller and edger, in order that the metal will fill the blocking die when ready for final shaping. The design of the blocker should be such that the metal will flow easily into the various parts of the die.

The finishing die should have well-defined radii and corners, so that the forging will be the exact shape and size. The complexity of the forging will determine the number of the above production steps needed, since all the work is accomplished in one operation.

When larger forgings are to be fabricated, separate die blocks are usually needed for the blocker and the impression. Flat dies, operated with 1500- and 3000-ton presses, do rough blocking and biscuiting as well as ingot breakdown and ingot drawing operations.

Another important consideration in designing forging dies is that proper draft allowance be made. In press forgings a draft angle of 0.25 degrees is usually adequate if the final shape of the forging fails to provide a natural draft.

Choosing Alloy

After careful consideration has been given to the fabricating problems involved, the proper alloy for a given forging job can be determined. [A table gives the chemical and physical properties of six aluminum alloys most commonly used for press forgings.] The choice of the alloy is generally determined by the ultimate use for the part. [Various alloys suitable for certain products or uses are recommended by the author.]

Ingot breakdown and ingot drawing operations are today more or less synonymous terms. The quality of forging ingot has so greatly improved in recent years that breakdown and drawing are now one and the same.

The utmost care should be taken in preparing stock so as to retain the most advantageous grain flow at points in the ultimate forging where the greatest stress will be borne. There is very little difference between hammer forgings and press forgings insofar as mechanical properties are concerned if the forging is made from the proper stock size.

If it were possible to carry a variety of shapes in stock, billets could be cut from rectangular, oblong and various ex-

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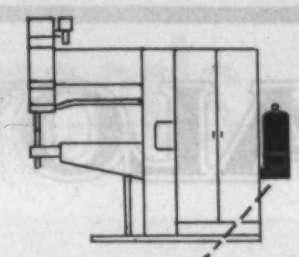

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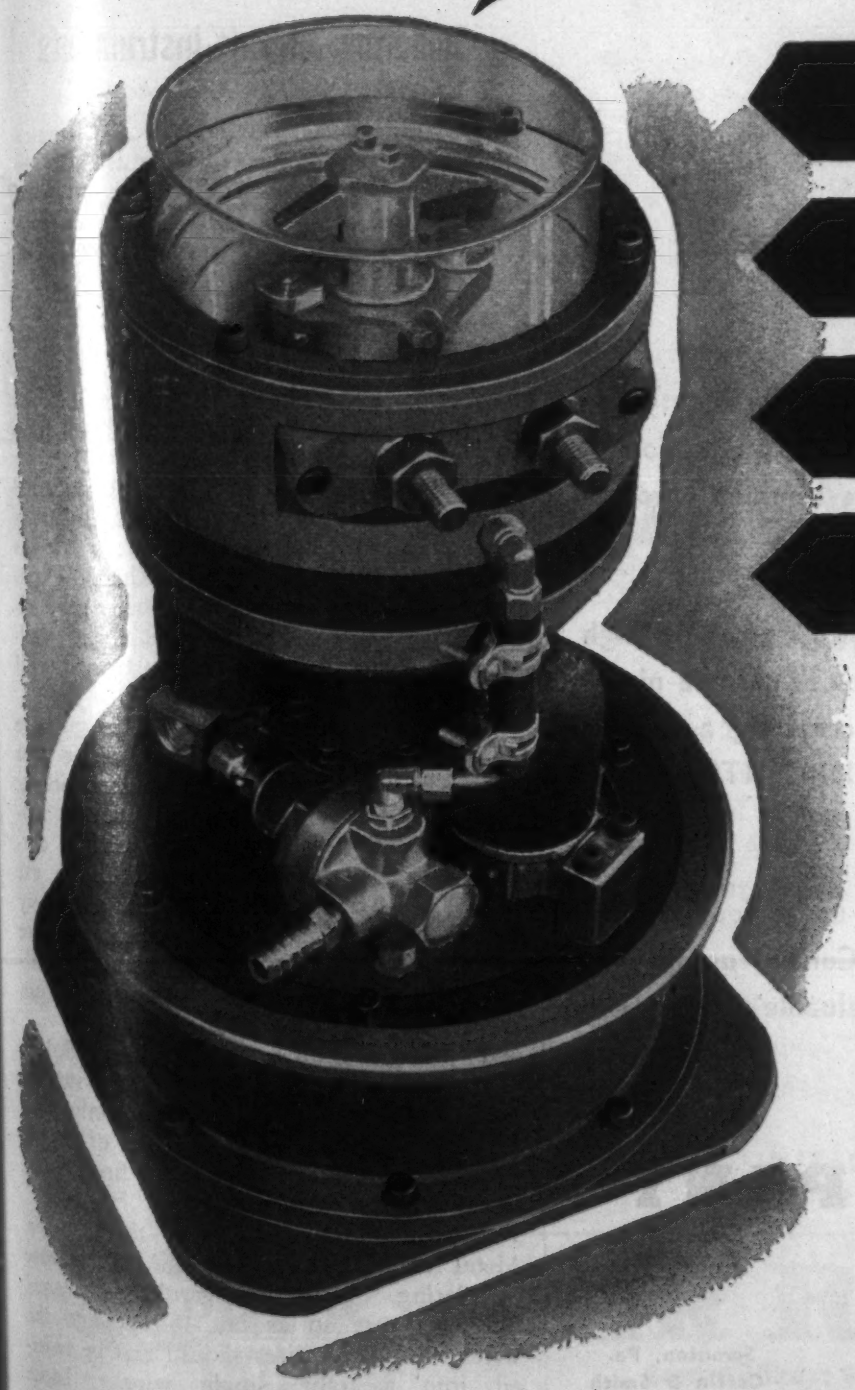

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SPEED INCREASED 20% OVER MACHINES OPERATING ON CONTACTOR SYSTEM

THE SCIAKY DYNATROL provides the answer to contactor problems on electro-magnetic stored energy resistance welding equipment. This high-speed device performs the function of accurately interrupting the charging current to the reactor without arc.

The problem of interrupting a d.c. current in a highly reactive circuit has always been considered difficult. On former Sciaky machines, this was accomplished by a contactor unit, which together with an arc-blowing device, arc-laminating shields, etc., produced a highly accurate interruption of the charging current.

However, in industrial production, the continuous arcing finally results in a deterioration of the contact tips, requiring periodical maintenance and replacement. It was considered desirable to solve this problem in such a way that the same consistent welds be produced without any maintenance of the interrupting device. To this end, the DYNATROL was developed and was found to be not only a means of more accurate and efficient current interruption, but also, because of the shorter charging time, actually increases operating speeds 20%.

The DYNATROL is available on all Sciaky Stored Energy machines up to 50KW.

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We can produce castings in any size from a pound or so up to four tons in weight, with the correct proportion of alloying elements. Consult us on your requirements. Our metallurgists may be able to render valuable advice that will help to solve your problem.

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truded shapes. However, economy does not permit this, and standard stock sizes are commonly used.

It is necessary in press forging work to cut a blank or shape for each forging rather than make a number of forgings off one length of bar, as in drop hammer work. Press work requires more careful stock preparation and perhaps a longer time to prepare the stock.

In order to prevent excessive sticking of the metal to the dies, it is necessary to lubricate the dies in forging operations. Press forgings require only enough lubricant to keep the forgings from sticking to the die. This results in much cleaner forgings and they, in turn, need less cleaning up by etching. The best lubricants employed on the mechanical presses are melted beeswax and combinations of waxes with graphite. The latter is the least expensive.

—*Heat Treating and Forging*, Vol. 29, Oct. 1943, pp. 510-514.

Soldering Aircraft Instruments

Condensed from "Instruments"

In soldering electrical aircraft instruments a tight clean joint must be obtained with no corrosive residue to harm delicate wiring and insulation. A joint should provide no case for voltage leakage or increase in resistance due to oxidation of the contact points.

A perfect soldered joint can be obtained only by the intelligent use of the soldering iron, by using virgin metal solder of good quality and by using rosin as a fluxing agent.

A few good rules that have been found from experience and from recommendations of solder and flux manufacturers are as follows: (1) Make a good mechanical connection, then solder bond. Where mechanical connection is not feasible, a well-cleaned contact point, correctly tinned, will solder with a lasting bond.

(2) Use only rosin flux. The purpose of the flux is to dissolve any oxide that covers the surface, so that molten solder can unite with the metal and prevent further oxidation. Fluxes are either corrosive or non-corrosive. Acid fluxes eat away the oxide, but they also eat away metal contacts and soldering tips, and have a harmful after-effect on insulation. Although acid fluxes do a faster job, rosin is preferred.

(3) Use a good grade of solder. Solder is composed of tin and lead in various percentages. Solders most commonly used for this work contain a mixture of 40-60, 45-55, 50-50 and 60-40, the first figure indicating tin content.

(4) Tin the work first—then solder. Metal should be free from dirt, grease or plating. Insulation should be cleaned off with care so as not to cut into the wires. Stranded wires should first be twisted into a tight, single wire. Loose strands should be cut off.

A soldering copper should be applied to the work to bring the wiring to a tem-

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metso *Cleaners*

perature sufficient to melt the solder, and only then is the solder applied to the work. Always use fresh solder and fresh rosin to insure a clean joint.

(5) Use the soldering iron intelligently. it should be a small 30-watt commercial iron, and should be connected to the proper voltage, and tinned on all four surfaces. If the iron is too hot, it will blacken the copper and burn the rosin. Never use sal ammoniac to clean or tin iron in electrical work.

During soldering an occasional rubbing of the tip over steel wool will restore the original luster. Failure to raise the work to the proper temperature will result in lumpy or stringy solder and a poor job.

(6) Take care of the iron. When not in use, keep cord wrapped around handle. Keep it from over heating, and keep it clean.

—J. J. Schiller, *Instruments*, Vol. 16, Aug. 1943, pp. 491-494.

Salt Bath Treatments

Condensed from "Automotive and Aviation Industries"

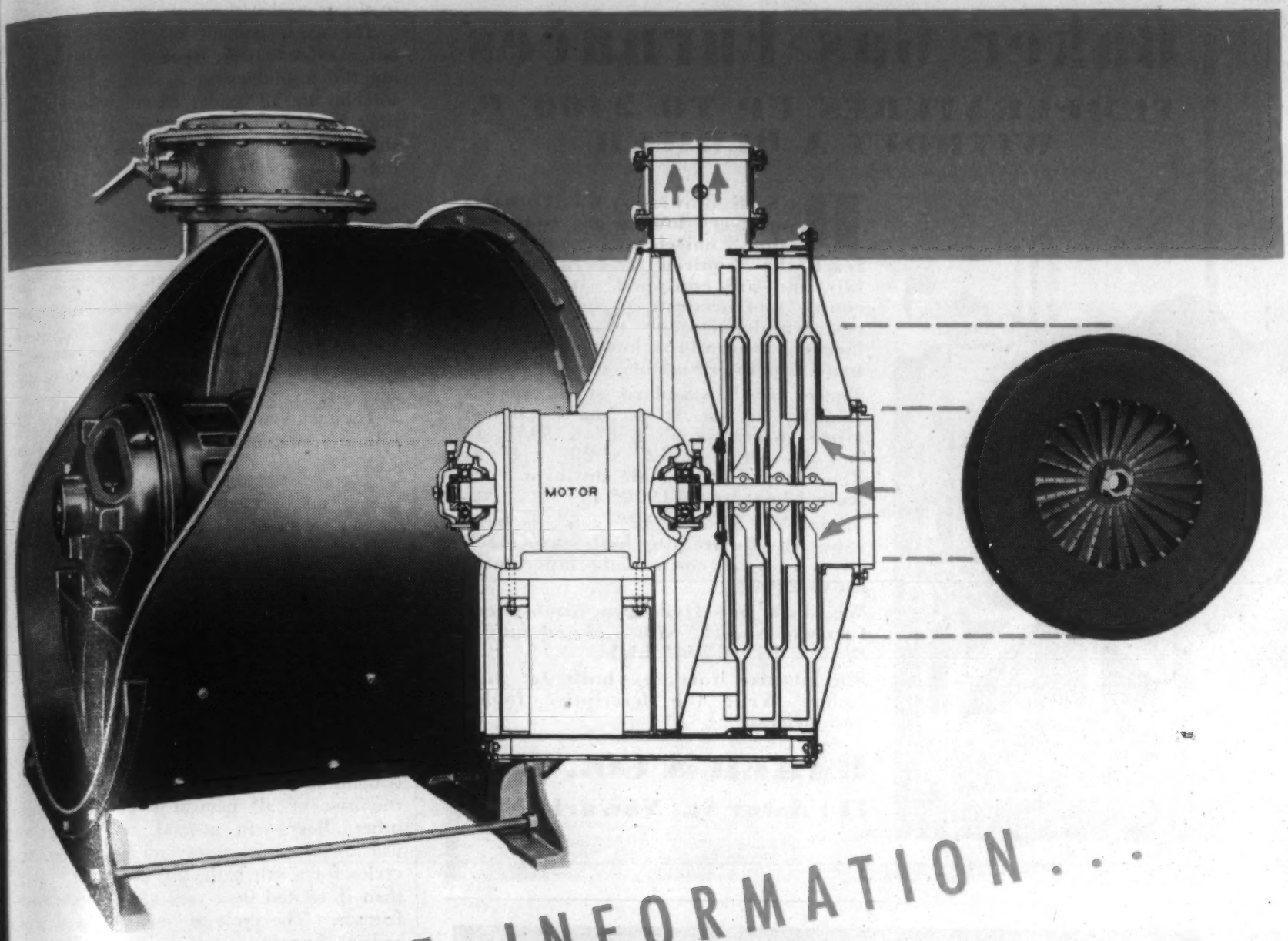
Before the era of the neutral salt bath furnace it was necessary to machine aircraft parts at hardness as high as 50 Rockwell C to remove contaminations, as carburization or decarburization cannot be tolerated. The neutral salt bath is gradually doing away with such machining. It is adapted to ferrous and non-ferrous parts; also for copper brazing assemblies, the salt acting as flux.

Materials can be left in salt longer periods without surface contamination. With steel one gets more complete transformation of austenite into martensite, these needing longer treatments; sometimes double heating is done, with interrupted quench between, which might cause contamination in atmosphere furnaces.

Formerly, one had to machine and thread grind all aircraft bolts after heat treatment. Now many airframe bolts are finished completely on screw machines, or are cold headed and thread rolled and treated in salt baths after finishing, with threads neither carburized nor decarburized.

For bolts of 30 to 40% C alloy steel the following is good. Preheat in salt bath at 1100° F. and transfer to another neutral salt bath at 1550°, soaking not less than 20 min. Quench in the preheat bath at 1100° and transfer again to the 1550° bath. Quench in oil down to at least 200° F. When at room temperature temper, usually for air frame bolts at 900°. If there is no neutral bath, an air circulating furnace may do, holding at not over 1050° F. Single heating may be used, but double is better.

For copper brazing, special atmosphere furnaces are better for quantity production, yet brazing can be done splendidly in salt, since at the needed temperatures of 1900 to 2200° F. this is more satisfactory than radiant heating. Atmospheres have a devitalizing effect on aluminum parts, cast and wrought. Artificial aging of the high



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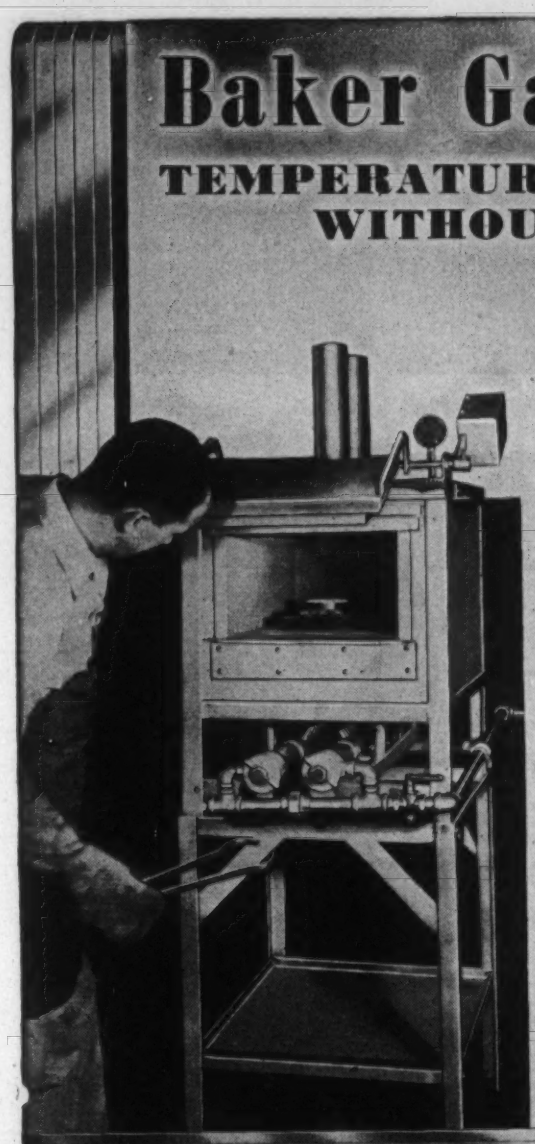

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tensile alloys is speeded up considerably in the neutral baths.

The oxide content of the bath should never exceed 10%, checked by determining the insolubles in a sample. The insolubles are all oxides except where a rectifier is present, the percentage of which should be known, from which the remaining can be calculated. Oxides may be reduced by a rectifier (generally a silicon compound) or by anhydrous ammonia.

The rectifier forms a slag, which sinks to the bottom as a sludge and should be removed at least every 24 hrs. The ammonia releases free hydrogen, which reacts with the simple oxides, passing away as gas. It is emphasized that material should not be treated in the bath while ammonia is being introduced.

The ammonia should be put in at an idling temperature, but not lower than 1450° F. It is not 100% effective, with a small amount of rectifier still needed. When in continuous operation, the bath should be renewed completely every 6 to 8 weeks. The internal electrode type of furnace is preferred, but gas-heated and external electrode-heated pots may be used. With the internal type, electrodes must be kept especially clean, to prevent corrosion and arcing. Electrodes welded to the holder are obtainable, as well as hand equipment for changing assemblies.

With gas-heated or external electric-heated pots, the pot must be an alloy of chromium and iron, since barium chloride, the base of all neutral salts, will attack other alloys. In general, it is better to use lower temperatures and longer heating cycles for a salt bath, say 25 to 50° lower than if treated in a radiant or atmosphere furnace. The cycle is one-half that for a radiant furnace.

—Stewart M. DePoy, *Automotive & Aviation Inds.*, Vol. 89, Nov. 1, 1943, pp. 38-40, 156

Quality in Aircraft Finishing

Condensed from "Industrial Finishing"

Production delays due to faulty finishing have been eliminated by the Douglas Aircraft Company by determining satisfactory finish schedules and the best production techniques, and then seeing that the specifications are followed in detail. Three basic phases of control are recognized: control of the packaged finishing material, of its preparation for use, and of its application.

It is not assumed that the fact that a package material meets a government specification justifies releasing it for use without testing. Such properties as grittiness, separation and skinning qualities, specific gravity, viscosity, drying time, color and spraying characteristics are checked. The material is prepared for use at one location in the plant, and the reduction ratios used for thinning are uniform for the entire plant.

The material used in greatest volume is zinc chromate primer, which is applied by roller coating, dipping and spraying. Alclad 24ST and Alclad 24SRT sheets are

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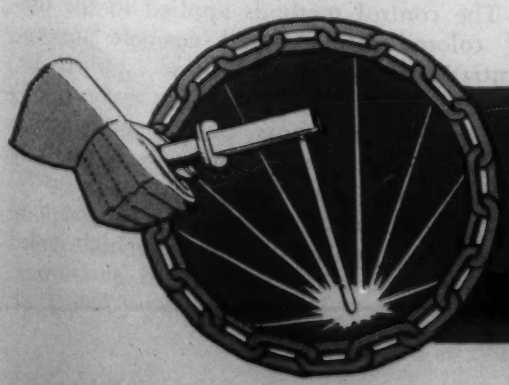

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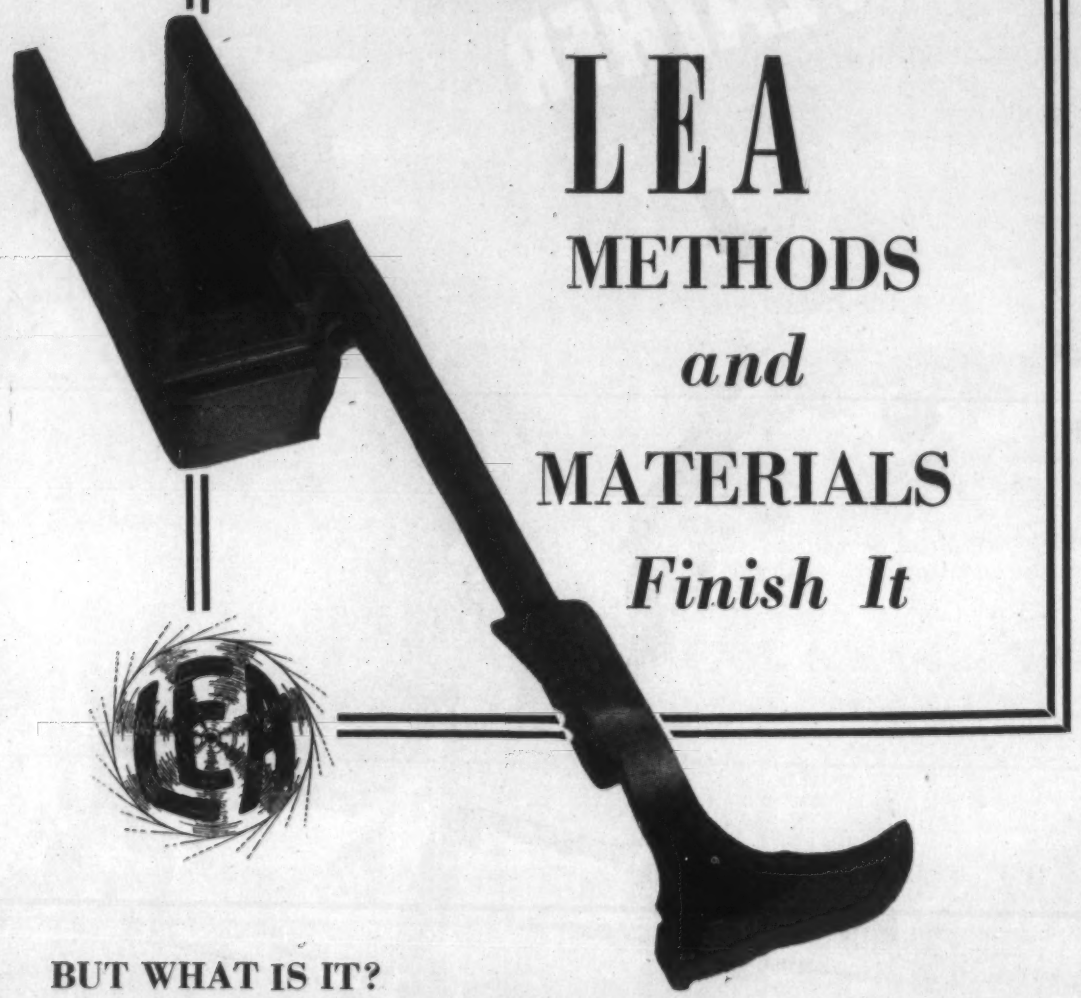

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uncrated, hardness tested, and immediately run through a sequence of operations, ending with roller coating with zinc chromate primer. The first stage consists of a hot phosphoric acid etch, followed by rinsing, drying and roller coating.

In the pretreatment etch it is necessary to control closely the phosphoric acid concentration and the temperature. The viscosity of the primer and the roller spacings must be closely controlled. Film thickness is maintained between 0.2 and 0.4 mils.

It is possible to apply the film in such a way that a slight but characteristic veined appearance is obtained. This appearance identifies any part subsequently formed from the sheet as having been Rockwell hardness tested and accepted, thus eliminating the labor of testing numerous small fabricated parts.

Preparing the Metal

Aluminum alloys are prepared for dip or spray application of primer by either anodizing or "chromadizing." Prior to these treatments the parts are carefully cleaned in a solvent emulsion, followed by a hot alkaline cleaner. The alkaline cleaner concentration and temperature must be controlled between proper limits.

Magnesium alloy parts are prepared for paint by either the chrome pickle treatment (Dow No. 1 Treatment), or the dichromate treatment (Dow No. 7 Treatment). The chrome pickle treatment consists simply of immersion of the parts into a solution of nitric acid and sodium dichromate. Operators are trained to recognize a satisfactory coating. In addition, frequent checks are made of the composition of the pickle, which may be replenished several times before discarding.

The dichromate process requires more accurate control than the chrome pickle. The steps of the process include an alkaline cleaning, hot water rinse, cold water rinse, 5 min. immersion in 15% hydrofluoric acid, cold water rinse, hot water rinse, 45 min. immersion in a 10% sodium dichromate solution at 195° F., hot water rinse and air dry.

The composition of all solutions is carefully maintained, and checks are made for possible carry-over of hydrofluoric acid into the dichromate solution, since this causes spotty and uneven coatings.

In controlling dipping solutions of primer, the viscosity is frequently checked. The thinner must be so chosen that selective evaporation of its components does not occur.

Spray application of primer is controlled by checking the viscosity of the paints and the pressure at the pressure pots and spray guns. Workers are properly instructed and supervised regarding spray gun adjustments and maintenance.

The control methods applied to the use of colored lacquers and enamels are essentially the same as those applied to primer. Primed surfaces that have stood for a week or more before receiving a lacquer or enamel coating are cleaned with a wash thinner, which may be used without too much danger of removing the primer and which will leave no high boiling component on the primed surface.

—W. D. Caldwell, *Industrial Finishing*, Vol. 19, Oct. 1943, pp. 34-48

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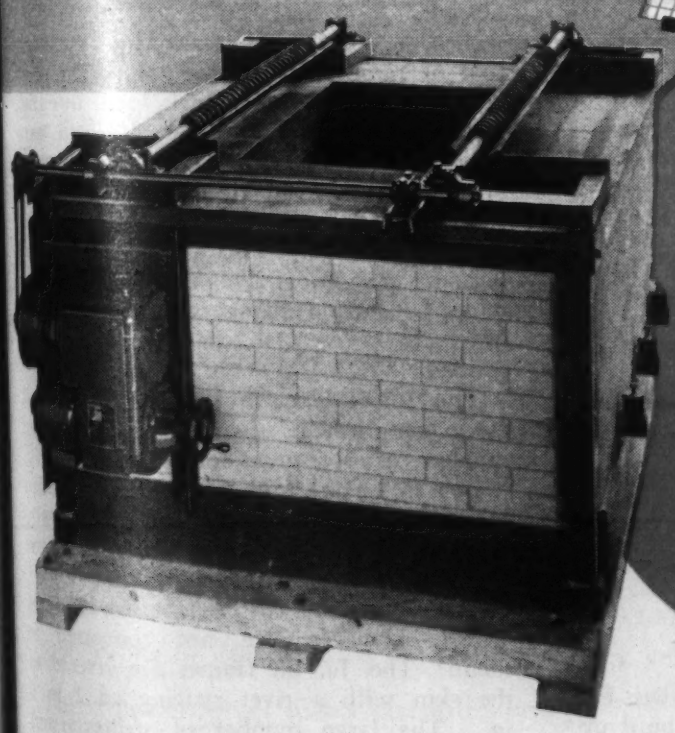

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German Aircraft Design

Eight main types of German aircraft have been examined: Heinkel He. 111, Junkers Ju 87, Ju 88, Dornier Do. 217, Messerschmitt Me. 109, Me. 110, Me. 210, and Focke Wulf F. W. 190. All eight types are entirely of metal construction. The last four of these are notable from the point of view of ease of production, maintenance and interchangeability of major components.

The wings of all these types are of the stressed skin construction, but only in the F. W. 190 does the skin take more than the torque and drag loads. The wing spars are all I section beams, with either extruded T section flanges or flanges built up from extruded angles back to back; the only exception is the He. 111, in which angle section spar flanges are used. Solid plate spar webs are used except in the He. 111 and Do. 217, where the spars are of built up girder form.

All eight types have fuselages of stressed skin construction. In general, the designs are notable for the small number of transverse frames and the large number of stringers used. The sections used for the fuselage stringers are: bowler hat for Ju. 88; inverted hat for Me. 109; top hat for Me. 210; lipped angle for F. W. 190; and Z section for Do. 217.

A single row of riveting is used for the Me. 109, F. W. 190, and Do. 217; the Ju. 88 and Me. 210 have two rows. The fuselage frames are Z sections for all except the F. W. 190, which has a lipped angle section (in the case of the Me. types the Z section is integral with the skin).

Only in the Ju. 87 and He. 111 is there any connection between the stringers and the frames. In the latter machine, the Z-section frames are placed inside the stringers and have no direct attachment to the skin, being riveted only to the stringers. This scheme involves no cutting of frames or stringer. The whole fuselage of the F. W. 190 is covered with light alloy sheeting cut in very large panels and flush riveted. The fin is integral with the fuselage.

Below the front end of the fuselage is a large panel, attached to the fuselage by screws, which gives access to the two fuel tanks. This panel is made from two large light alloy sheets, the internal sheet being dished at about 5 in. centers and attached to the external sheet by a single rivet at the bottom of the dishing as well as by rivets around the edges. This gives a very stiff panel and is used also in the fin, in parts of the engine cowling, and for an inspection door in the side of the fuselage.

Messerschmitt Designs

The most interesting method of fuselage construction is that used in the Me. 210 as well as in the other Messerschmitt designs. Top hat section stringers are attached to the skin, each by a single row of rivets through the top. The skin and frame, 0.05 in. thick, are integral, the two transverse edges of alternate panels being bent up to form Z-section flanges on the inside of the fuselage.

The fuselage is built in two halves, with longitudinal seams along the top and bottom. The two halves are joined by two wide hat section stringers using two rows of rivets in each so that butt joints are formed.

The Ju. fuselage is quite different and more complicated. In addition to a large number of stringers formed from strip, there are also four T-section extruded longerons. There is a total of 45 stringers, all continuous; they are attached to the skin by two rows of rivets each.

The frames are cut out for the stringers which, however, are not connected to them. The Ju. 88 frames are riveted to the skin with a rivet spacing of 2 to 3 in. The large number of stringers and method of attachment leave very little unsupported skin.

Although the result approaches a theoretically desirable condition, it involves the use of at least twice the normal number of stringers and about three times the normal number of rivets.

The four fighters (Me. 109, 110, 210, F. W. 190) use fabric-covered control surfaces; metal-covered surfaces are used on the others. Castings and welded components are used for many important struc-

DESIGN DATA ON PLASTICS

FROM THE DUREZ LABORATORIES

II. Cost Factors

The basis for good design in plastics is not unlike that for any other material. Attention must be given to the fundamentals involved in the benefits of one plastic material over another, molding and finishing needs, and the cost of the finished product.

The subject of costs emphasizes the importance of working closely with your custom molder. Bring him into the picture early. His experience can result in substantial economies. There are many instances when he has shown that molding costs were excessive. We know of other occasions when he has helped to eliminate an unnecessary production expense or costly machining operations in the mold.

Good design gives every possible consideration to easy removal of the piece from the mold. Intricate shapes are being molded every day with Durez phenolics, but production costs are reduced whenever a complicated mold is avoided. Split molds, for instance, mean additional press time for assembling and disassembling this mold.

Simplicity saves money. It has been pointed out, however, that the cost of a seemingly complex part may be warranted by a saving in later machining and assembly operations.

Inserts frequently hand the designer a cost problem. Generally speaking, the inclusion of inserts in the molding operation will prove an advantage. Though molding costs are high, they too are offset by time and labor savings in final assembly.

If possible, design should provide for making projecting inserts round. When odd shapes are tooled in the mold, additional costs are usually involved.

As a suggestion, your molder may have a selection of well designed inserts which are produced in such volume that they can be used most economically.

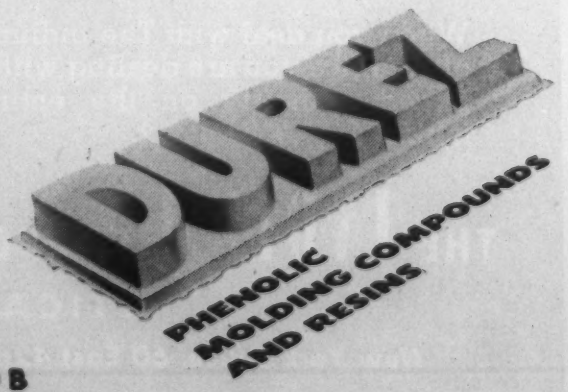
There are times when tolerances are called for which are closer than actually needed. These tolerances can be furnished but they add to costs by slowing production. And the more leeway given the mold maker, the less expensive the mold.

In cases of extremely exacting tolerances it may prove better to mold slightly oversize and then machine to the required specifications.

Good design seeks to eliminate undercuts. They mean additional mold costs and slower production. There have been recent developments in molding with Durez phenolics which have answered some of the problems. The designer does not have to be restricted if undercuts are essential.

Fillets are another interesting cost factor. Though they are used to facilitate flow and build up structural strength, they often serve to simplify mold construction. In such cases a less costly mold is achieved.

Here, we can give only a few of the cost factors in plastic design. A major consideration in the popularity of Durez phenolics is their low cost advantage. When this advantage is added to their moldability which makes them easier to use, and the broad scope of their properties through a wide range of temperatures, you can see why we suggest that you give careful consideration to Durez phenolics. We welcome the opportunity to work with you on any plastic material problem. And a member of our technical staff will be glad to assist you with additional data. Durez Plastics & Chemicals, Inc., 92 Walck Road, North Tonawanda, N. Y.



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unit castings in the F. W. 190 and Do. 217 are notable as well as the welded tubular supporting struts in the liquid cooled engine mountings, and the welded tubular engine mountings for radial engines.

The use of plastic materials is limited to such items as guides for control wires, guide rollers for large control tubes, pulley wheels, drive couplings for engine accessories, Ju. 87 aerial mast, electrical and radio fittings.

Extruded sections are used to a very limited extent and then only of the simplest T, D, or I section, the best example being the F. W. 190, in which the only extrusions are the rails for adjustment of the pilot's seat. On other types, extrusions are used only where the sections are too thick to be formed from strip.

The lack of extruded sections is less marked in the Me. 210, where they are used in the main plane and tail plane spar flanges, for the dive brake slats, and for a number of structural members in the front fuselage as well as for some ingenious mounting slides for the multiple sockets used in the wing to fuselage electrical connections. Protective treatment against corrosion is used only to a small extent.

The Messerschmitts seem to be the most advanced in regard to design for ease of production and maintenance. Interchangeability troubles are avoided to a large extent by the methods used for the connection of sub-assemblies that facilitate initial assembly and maintenance and render very accurate jigging unnecessary.

Although the arrangements for engine changing in all types are good (the engine complete with accessories, mounting and cowling can be removed as a unit), the engine installations are frequently not so convenient for minor maintenance work. German airplanes are always well provided for quickly detachable inspection covers in wings and fuselage.

—*Sheet Metal Inds.*, Vol. 18, Oct. 1943, pp. 1793-1800.

Iron Castings for Machinery

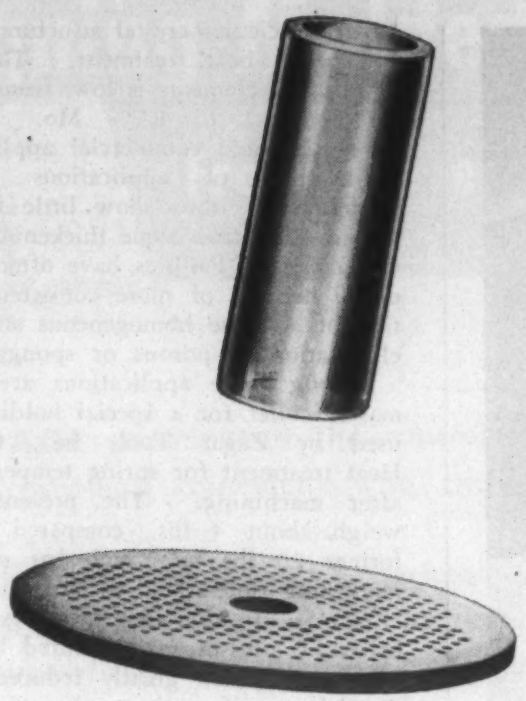
Condensed from "Product Engineering"

Wartime necessity has led to rapid adoption of high-strength cast irons as replacement materials. Many changes will be permanent because of advantages obtained in service and reduced cost.

A group of about 20 cast irons, called Meehanites, makes use of calcium silicide as an inoculant to control formation of a homogeneous structure in the iron. Production of cast irons of 50,000 to 60,000 lbs. per sq. in. tensile strength has been reported with neither alloys nor special agents as graphitizers.

A nickel-moly iron has tensile strengths up to 100,000 lbs. per sq. in. These

(Continued on page 454)



What can GLASS do for your Product?

CORNING manufactures glass percolators as a part of the "Pyrex" ware line. Prior to 1942 these percolators were equipped with aluminum or stainless steel baskets for holding the ground coffee. The critical shortage of these customary materials added impetus to a long-standing development—an all glass basket which is inherently sanitary, easily cleaned, and eliminates all contact of coffee with metal.

The glass percolator basket was not evolved over night. Embodied in its manufacture are four major glass fabricating developments representing years of patient research on the part of Corning engineers:

1. *Automatic machinery to blow the basket shell in quantity at low cost.*
2. *Automatic tube drawing machinery to make the accurate center stem at low cost.*
3. *"Pyrex" Multiform Glassware that makes the perforated basket bottom with its uniform holes.*
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have an acicular crystal structure produced by special heat treatment. The content of alloying elements is low, from 1 to 5% Ni and 0.1 to 1.5% Mo. Priorities have prevented commercial applications.

Examples of applications of high-strength cast irons show little if any redesign other than some thickening of critical sections. Failures have often been reduced because of more consistent production of a dense homogeneous structure or elimination of porous or spongy areas.

Among these applications are: (1) A master collet for a special holding fixture used by Zagar Tool, Inc., Cleveland. Heat treatment for spring temper is given after machining. The present castings weigh about 4 lbs., compared with the former 20 lbs. of rough bar stock, and machining time is cut to 1/5.

(2) Substitution in pressure cylinders of hydraulic presses manufactured by E. W. Bliss Co., which greatly reduced time in the delivery of castings, almost eliminated structural flaws and spongy areas, and cut machining time in half.

(3) A cylinder housing for a rock drill manufactured by Cleveland Rock Drill Co., which shows the ability of Meehanite to withstand impact and fatigue stresses and eliminates scoring.

(4) A rope drum, in which cast grooves are satisfactory in place of those machined in semi-steel drums, and for which paint and wire rope lubricant are sufficient protection against corrosion.

(5) Davit head rollers, galvanized against corrosion, which do not flatten with the rolling motion of a ship as those of bronze do.

(6) Lathe spindles, in which the lack of ductility of the cast iron is an advantage and there is a large saving in cost.

(7) Tool slides, where Meehanite of 50,000-lb. tensile strength is heat-treated to a Brinell of 269, and tool shanks, machine frames, gears, cams and milling cutter heads.

—*Product Engineering*, Vol. 14, Oct. 1943, pp. 659-662.

Structural Properties of Metals and Plastics

Condensed from "Light Metals"

At the present stage of development of the plastic industry the materials that offer the greatest promise of success for structural purposes are laminated phenol-formaldehyde, compressed wood and bonded plywood. Properties of such products vary according to the nature of the material used. With phenol-formaldehyde, tensile strengths of 10,000 to 30,000 psi are obtainable. Much higher values may be obtained by use of special fibers.

Comparing the properties of laminated 1/16-in. birch veneers with AZM magnesium alloy, duralumin and mild steel, results show that the adoption of a tie of a plastic material has the effect of reducing

Designing Molded Plastics Parts: SHRINKAGE

From the engineering files of One Plastics Avenue

SHRINKAGE encompasses the contraction and distortion problems coincident with the molding and application of the plastics part. Immediate molding shrinkage can usually be estimated within plus or minus .002 inch per inch. Shrinkage varies with the type of resin and filler and is influenced by the molding technique employed.

With proper design consideration given to factors known to affect ***shrinkage***, molded parts can be produced economically which satisfactorily fulfill functional requirements.

GENERAL CONSIDERATIONS

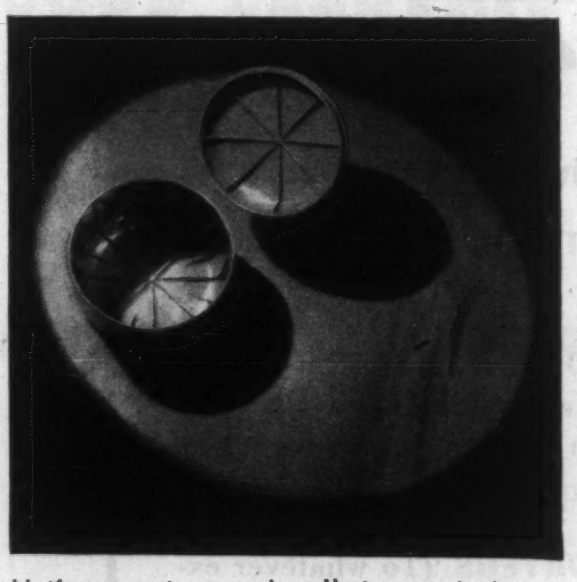
1. *Uniform cross sections* minimize uneven stresses, provide greater strength.
2. *Ribs*, properly located, minimize warpage.
3. *Inserts* (material, size, placement) influence shrinkage behavior.
4. *High temperatures* cause certain plastics to shrink while in use.
5. *Age* causes certain plastics to shrink.

MOLDS AND COMPOUNDS

Molds must be designed larger than the desired final part to compensate for shrinkage.

Because the shrinkage of various types of compounds is not the same, dimensions of parts molded in a common mold from different materials may vary.

(Cooling fixtures are used when there is an excessive tendency for the part to warp.)



Uniform sections and well designed ribs on Textolite float minimize dimensional variations due to shrinkage

INSERTS

Anchorage of inserts is aided by shrinkage of surrounding plastic. Wall thickness of plastic necessary to insure adequate anchorage of insert is determined by—

1. Type of insert material
2. Size of insert
3. Number of inserts used
4. Relative position of inserts
5. Type of compound employed

TYPE OF MOLDING

Shrink marks may appear at rib junctions on parts made in hot compression molds.

Design injection molded parts with minimum wall thickness to minimize voids, bubbles, and surface shrink marks.

Shrinkage allowance should be more on cold molded parts because of cure necessary after molding.

Appearance of large flat areas can be improved by incorporating decorative designs on these surfaces or making surface slightly convex.

General Electric is the nation's largest plastics manufacturer. The combined experience and plastics "know how" of its chemists, designers, plastics product engineers, toolmakers and molders are available to those interested.

For additional information about the manufacture or application of improved Textolite plastic materials write section F-213. General Electric Company, One Plastics Avenue, Pittsfield, Mass.

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THE PLASTIC CORROSION RESISTANT COATING

the weight about 81% of that of the equivalent steel member, 51% of that of the equivalent duralumin member, or 39% of that of the equivalent AZM alloy.

Subjecting specimens to a compression test to determine their ultimate strength, the length of the specimen must be decided on. If it is too short, block action may occur. If, on the other hand, the specimen is too long, column action will result.

The ultimate compressive strength of laminated 1/16-in. birch veneer is approximately 8 tons per sq. in. In the case of AZM alloy, a mean ultimate strength of 24.4 tons per sq. in. is obtained, while for duralumin and aluminum alloys the ultimate compressive tensile strengths are 25 tons per sq. in. For many mild steels the ultimate strength in compression is equal to that of tension, which is about 27.5 tons per sq. in.

From results obtained, while there is no great difference between the deflections exhibited by duralumin, AZM alloy and plastic beams, the deflections are considerably greater than that resulting from the use of a steel member of equal strength.

In the case of the plastic member, the assumption has been made that the load is applied in the direction parallel to the plane of lamination. A greater deflection would result from application of the load at right angles to the plane.

—Leslie P. Dudley. *Light Metals*, Vol. 6, Oct. 1943, pp. 480-485.

Strength at High Temperatures

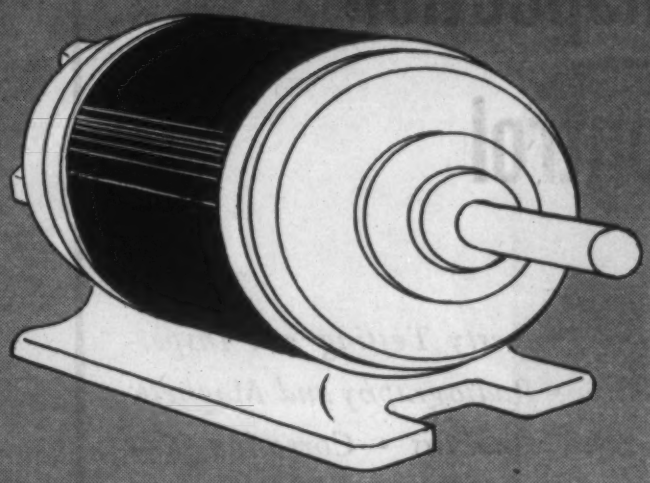
Condensed from "Metal Treatment"

To determine how far the enhanced mechanical properties developed in aluminum alloys by heat-treatment are retained in service at high temperatures, as in aircraft engine pistons, tests were made on samples of Hiduminium R.R.59, a wrought aluminum alloy containing 2.2 Cu, 1.5 Mg, 1.0 Si, 1.0 Fe, 1.0 Ni and 0.05% Ti.

The best combination of mechanical properties in this alloy is obtained by heat-treating at 170° C. (338° F.) for 15 to 20 hrs., or at 200° C. (390° F.) for 10 hrs. The Brinell hardness of the fully heat-treated alloy falls only slowly with increasing temperature up to 150° C. (300° F.), but little permanent softening is produced even after 200 hrs. A noticeable decrease is produced, however, at higher temperatures; although even after 200 hrs. at 300° C. (570° F.) the alloy is not completely softened and the true annealing temperature is 350 to 375° C. (660-705° F.).

Short-time tensile tests at elevated temperatures showed that the ultimate stress varies with temperature in a similar manner to the Brinell hardness; fully heat-treated material is appreciably stronger than the annealed alloy after 200 hrs. at 250° C. (480° F.).

—A. G. H. Damerell, *Metal Treatment*, Vol. 10, Autumn 1943, pp. 139-145.



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Testing with High-Speed Cameras

Condensed from "Industrial Power and Production"

Many industrial problems have been solved by means of high-speed photography. The equipment varies, depending upon the requirements of the job. Sometimes a special shutterless camera is used where the film moves continuously past the lens while the lighting is intermittent. The light source is capable of flashing 1000 times a sec., with the duration of each flash about 1/250,000 sec.

An electrical condenser is continuously charged from the mains and discharged through an argon filled tube. 1000 exposures a sec. are obtained instead of the usual 16. In other cases, as for example where the object emits its own light, the intermittent lighting is obviously unsatisfactory. Then it is necessary to use a camera where the image moves with the film.

There are three kinds of such cameras, all with the same principle: rotating lenses or slits, rotating mirrors, rotating prisms. With one particular timing mechanism, it is possible to obtain 2500 exposures a sec. on 16-mm. film.

The results of such photography help engineers both in overcoming mechanical difficulties and in designing new machines. The action of shuttles and other fast moving parts in cotton spinning equipment has been examined more thoroughly with reduced film speed than is possible in the factory. It has been possible to trace the cause of defects in the finished product.

Other problems that have been studied are: Distortion in airplane propellers in service, valve spring surges, the slip of die blocks in the reversing link of a fast-running reciprocating steam set, the operation of automatic telephone equipment, typewriters, comptometers, etc.

The operation of an internal combustion engine has been followed by means of pictures taken through a quartz window inserted in the combustion chamber. In some cases, where the object being studied is very small, the film can be enlarged for better observation.

In a special branch of high-speed photography, used in some ballistic studies, the pictures are taken of the shadow of the object rather than the object itself. For example, studies have been made of the atmospheric disturbances created by spark discharges with the detonation of explosive mixtures as this is accompanied by high compression waves that traverse the surrounding atmosphere setting up changes in the refractive index of that medium. This method is also used for following the flight of a bullet, as this sets up atmospheric disturbances in the immediate vicinity.

High-speed single shot X-ray photography is another phase of this subject. It has been used for investigations of the operation of electric vacuum cleaners. X-ray motion pictures have been used for studying the flow of molten weld metal in electric welding, and has given valuable information on the design and composition of electrodes.

—G. McArd, *Industrial Power & Production*, Vol. 19, Oct. 1943, pp. 214-217

Inspection Innovations

Condensed from "Steel"

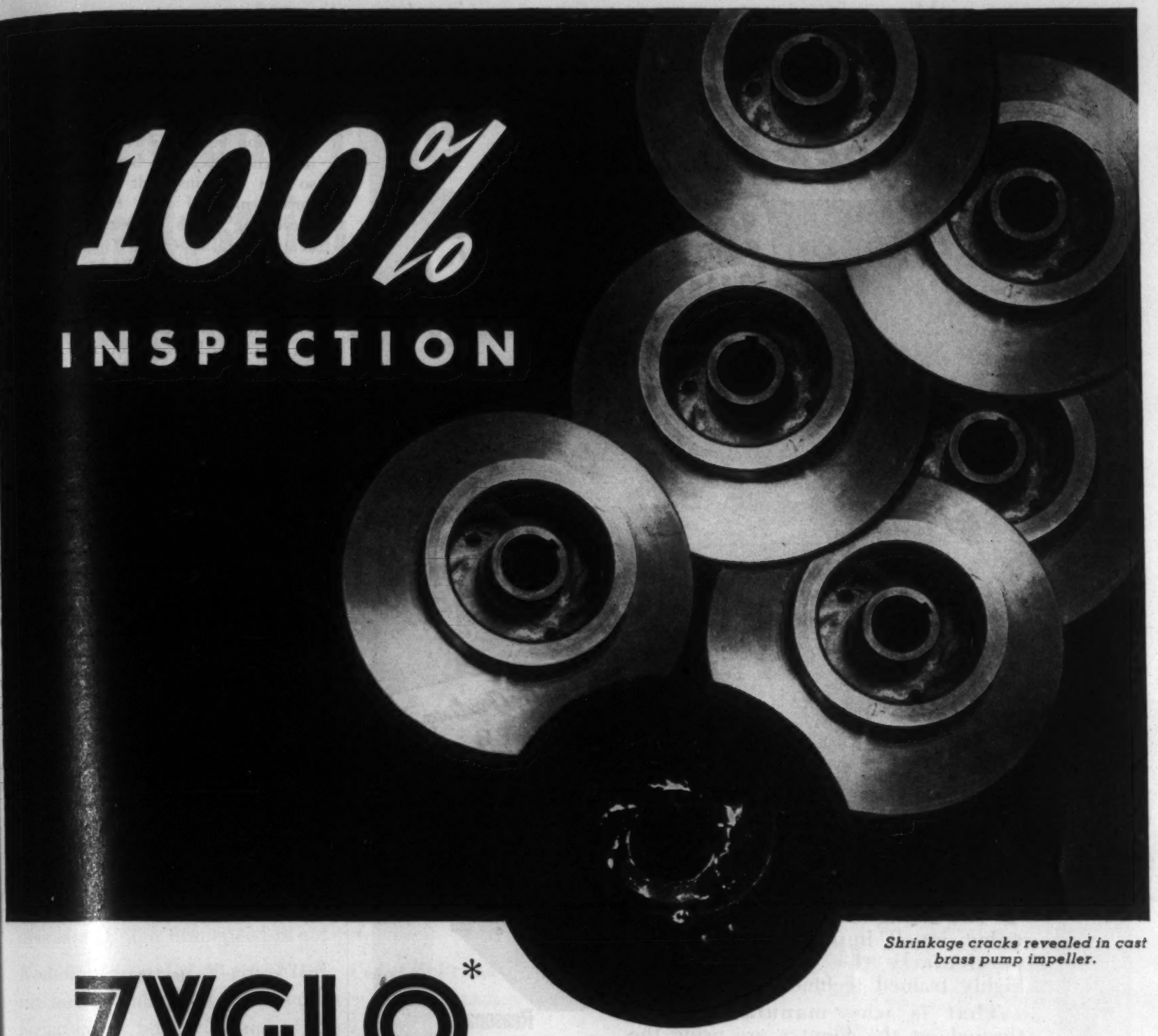
Nash-Kelvinator Corp., Detroit, Mich., uses a combination of time-saving ideas and improvements that increase efficiency and smoothness of 100% inspection in manufacturing a large number of relatively small precision parts. These include the use of a production illustration, gage boxes, gage board, and segregation rejected parts.

The production illustrations are 8½ x 11-in. blue-prints, which are hung at each machine and have heavy lines to show particular operation to be done at that machine, together with the necessary dimensions and limits. Tools and gages to be used by the operator are specified on the print.

Special boxes provide all gages for one group of inspections. There is a place in the box for each gage. Masters for setting indicator gages are also included whenever required.

Each operator is assigned a box, num-

100% INSPECTION



Shrinkage cracks revealed in cast brass pump impeller.

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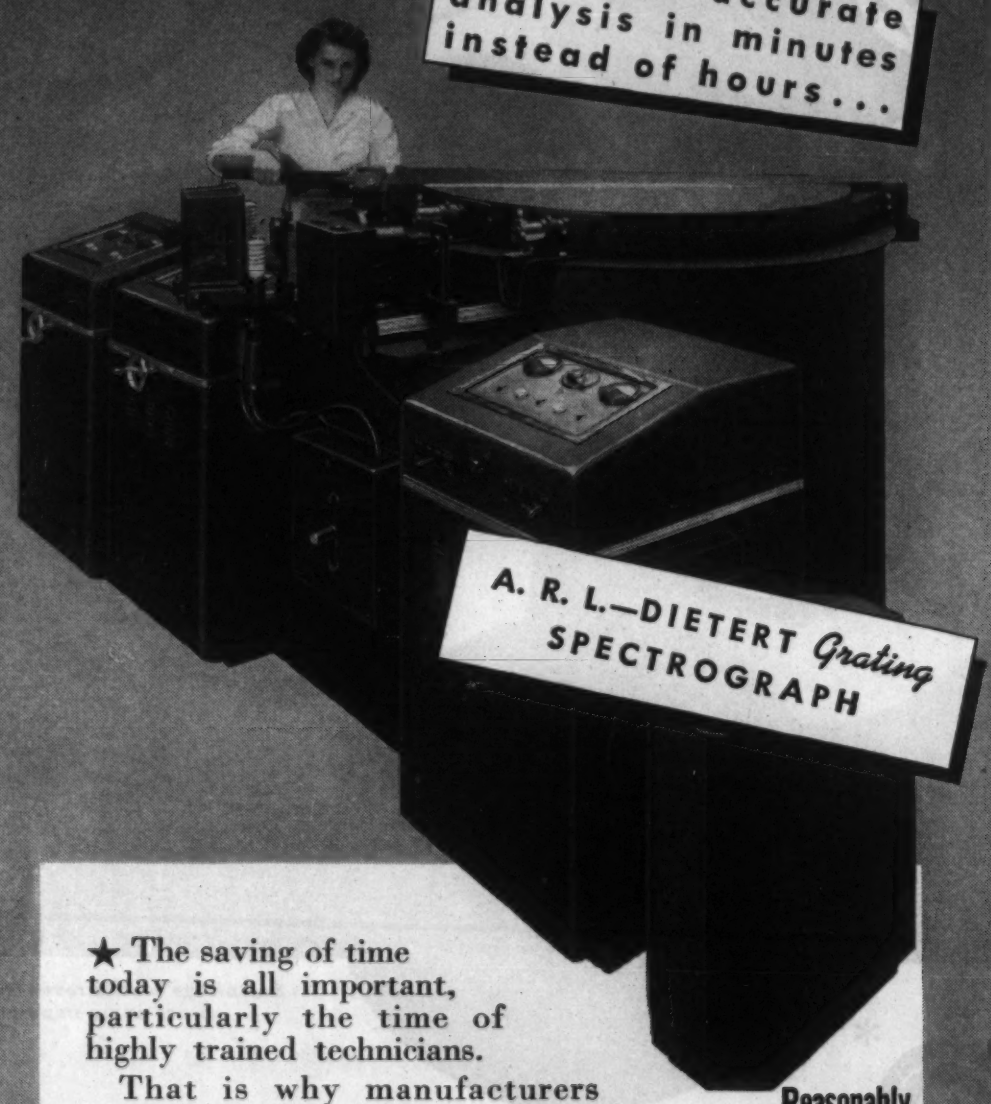

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bered to correspond with the number of the operation he is performing. Gages are removed and replaced easily and quickly. They are arranged in logical order.

Similar gage boxes are also provided at inspection benches. The number of gages in each inspector's box is proportioned so that each inspector requires about the same length of time for his task, thus preventing pieces from piling up because of a "slow" inspector. Gages are grouped according to logical mechanical divisions of the part being inspected.

The gage boards are heavy plywood boards on which gages are fastened down, but positioned ready for use. The part to be gaged can be tried easily and quickly in or on each gage.

For segregating rejected parts, tags are provided, which have outlined drawings on them. There is a separate tag for each type of part. Inspectors write on the tag the nature and amount of the error, and indicate the location on the outline drawings. Tags also bear information that permits the trouble to be located quickly and corrected, and designation of disposal.

Parts that have identical errors or faults are grouped, and one tag may cover a quantity. An orderly system of boxes to hold each type of reject is arranged along the back of the inspection bench. The salvage department knows at a glance what correction is needed to save the part, or can decide on the necessity of scrapping it. This system has eliminated much paper work, reduced scrap, and increased the amount of rejects that can be salvaged.

—*Steel*, Vol. 113, Oct. 11, 1943, pp. 174-175, 276-277.

Earth-Filled Walls for X-ray Building

Condensed from "Engineering News-Record"

X-ray equipment in the new research laboratory at Ohio State University is housed in rooms having thick earth-filled concrete walls. The walls around the two rooms have a minimum thickness of 5 ft. The inner and outer faces of these walls are of concrete block 1 ft. thick. Between these faces 3 ft. of earth fill was added. Operators near the equipment are protected by a wall 10 ft. thick.

The walls are supported on continuous spread footings made of plain concrete to save steel. They are tied together by 8 x 8 in. reinforced concrete ties on about 4 ft. spacing both ways. Cells in the concrete block are filled with mortar. The only steel used were some 12-in.-long rods to tie the walls to the roof slab and footings, and four ⅜ in. rods in each concrete tie.

Observation windows consist of 4-in. diam. pipe closed at each end with a ½-in.-thick plate glass plug and filled with clear water. Thus, the operator observes the experiments through 10 ft. of water.

Here are the Four Kodak Films for Industrial Radiography . . .

RADIOGRAPHY is being given so many widely differing assignments today—with so many differences in the size and shape of the parts inspected . . . in the materials used . . . in the type of information sought . . . and in the radiation employed—kilovoltages from 5 to 1000, as well as gamma rays . . . that one type of film is no longer enough for the work. Kodak supplies four distinctly different types—with individual combinations of characteristics designed specifically for the exacting requirements of the industrial field . . .

Kodak Industrial X-ray Film, Type M Primarily for million-volt work. This newest Kodak Film has extra fine grain, high contrast, and is particularly effective for most million-volt work . . . for aluminum and magnesium alloys at average voltages . . . and, for general use, where highest definition is desired and high film speed is not required.

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Kodak Industrial X-ray Film, Type F Primarily for the radiography, with calcium tungstate screens, of heavy steel parts. Has the highest available speed and contrast with calcium tungstate intensifying screens. Also used for gamma radiography—direct and with lead-foil screens.

Kodak Industrial X-ray Film, Type K Primarily for the radiography, direct or with lead-foil screens, of lighter steel parts. Has the highest available speed in direct x-ray exposure . . . when used with lead-foil screens at higher voltages . . . and, for heavier parts, with gamma rays.

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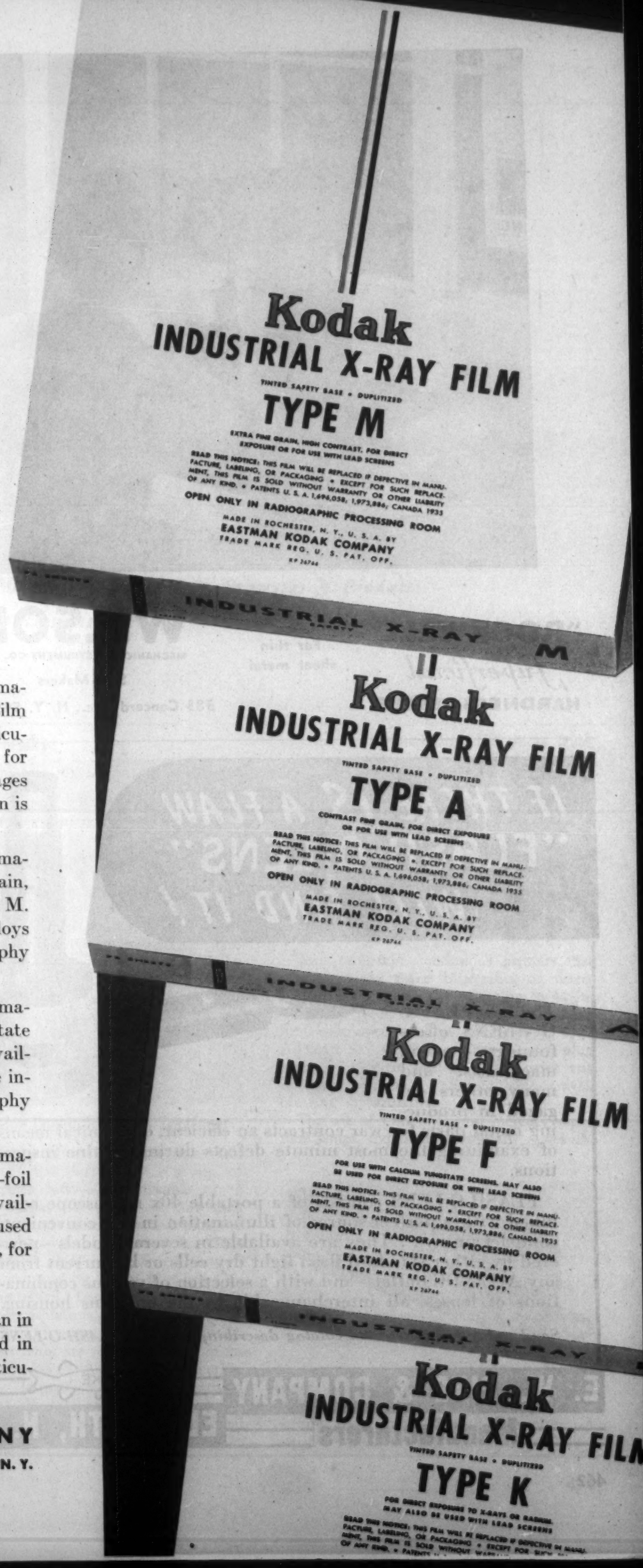
X-ray Division **Rochester 4, N. Y.**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All pipes for water and electrical conduits are laid out with elbow turns that eliminate direct openings.

The roof consists of 12-in. reinforced concrete slabs covered by a 3-ply built-up roofing. The exterior walls were given two coats of waterproof tinted stucco, and inner faces of the walls were left unfinished. Total cost, exclusive of equipment, was $18,000.

Lead lining of the rooms would have had to be 12 in. thick, which meant that several tons of critical material would have been required.

—*Eng. News-Record*, Vol. 131, Oct. 21, 1943, pp. 126-129.

Pseudomorphs in Quenched Steel

Condensed from an American Society for Metals Paper

Induction heating is so rapid that, theoretically, the steel can be heated and quenched before any change has occurred other than that of alpha to gamma iron. Practically, however, the rate of diffusion of carbon in gamma iron is so high that it is impossible to prevent the transfer of some carbide from the cementite to the surrounding austenite.

Steel of approximately the following composition was tested: 0.63 C, 0.3 Si, 0.8 Mn, 0.75 Cr, 0.3 Mo, 0.8% Ni. Shot of this analysis was heated by induction to 1565-1585°F. in 130 sec. and vigorously quenched 30 sec. later. If the prior structure was spheroidized cementite, the hardened structure consists of martensite with some undissolved carbides. However, if the prior structure was lamellar pearlite, the hardened structure may be an almost perfect pseudomorph of pearlite. In both cases the hardness after quenching is about Rockwell C 62-63.

The conditions requisite for the production of the pseudomorph of pearlite are somewhat critical. If either the maximum temperature or the time the steel is above the critical range before quenching are increased, the steel loses is pseudomorphic structure and may exhibit, after quenching, a vermiform martensitic structure.

Pioneer work in induction heating recognized the rapidity of the heating. Therefore, it has been recommended that the steel used should be "either previously heat treated to a predominantly sorbitic structure or normalized to obtain a grain size that approaches the heat treated structure."

The author suggests that pseudomorphic structures such as he has found may have properties worthy of fuller study and application and that in the future, therefore, less stress should be placed on ensuring that diffusion occurs during induction heating.

—O. W. Ellis. A. S. M. Preprint Oct. 1943 meeting, 11 pp.

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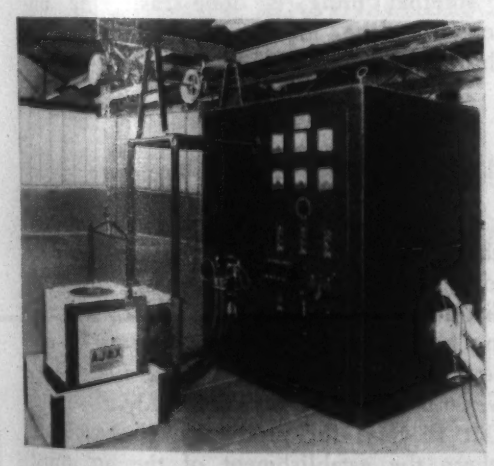
Induction Furnace for Brass Foundry

Two hundred pounds of uniform, homogeneous brass can be melted and cast in 50 min. with the new, compact, simple, clean and cool-to-operate 50 kw., cubicle-type Ajax-Northrup life-coil induction furnace unit. Designed by *Ajax Electrothermic Corp.*, Ajax Park, Trenton 5, N. J., for small brass foundries, the unit adapts all the advantages of melting by induction to present-day small foundry pouring practice.



The sturdy steel crucible houses all electrical control equipment, the 50 kw., 3000 cycle motor-generator set, capacitor units for high power efficiency, contactors and motor starter. It is completely wired, the only connection necessary being for cooling water and 3-phase, 60 cycle power.

All the heat goes into the charge. The electrical current induced in the charge stirs the metal thoroughly as it melts. The charge is placed in an ordinary crucible and the lift coil furnace is lowered around the crucible by a hand-hoist.

When the charge is molten, the furnace coil is lifted and the crucible is picked up in a shank and poured.

For continuous operation, two crucibles can be mounted on a small truck. While the charge in one is being melted the other is poured. A sand seal around the base of the lift coil prevents any chimney effect.

Adjustable Counterbore and Spotfacer

The feature of a new counterbore and spotfacer is that instead of a group of fixed-diameter bits interchangeable on a standard shank, the blades of this item themselves are adjustable to any diameter within the broad limits of the tools. This new adjustable blade counterbore and spotfacer is announced by *Robert H. Clark Co.*, 3424 Sunset Blvd., Los Angeles 26.

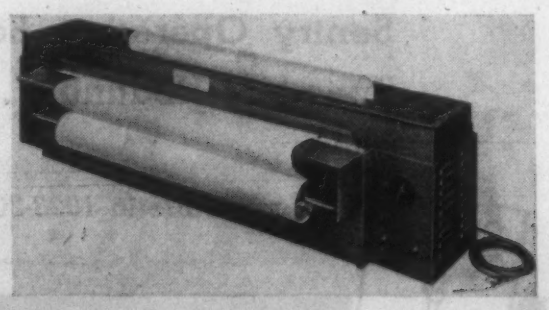
A no-burr feature is incorporated. Thus, each of the interchangeable pilots is so designed that burrs are prevented from forming at the edge of the pilot hole, thereby avoiding "locked" pilots and resulting damage to the tool and work. The complete range of 8 sizes covers all fractional and decimal diameters from 9/16 in. to 5½ in., with interchangeable pilots from 3/16 in. to 5¼ in. diam. Each of these tools does the work of several fixed-radius counterbores.

The blades are of Tan Tung, a tough non-ferrous cast alloy, and are removable for easy resharpening or replacement.

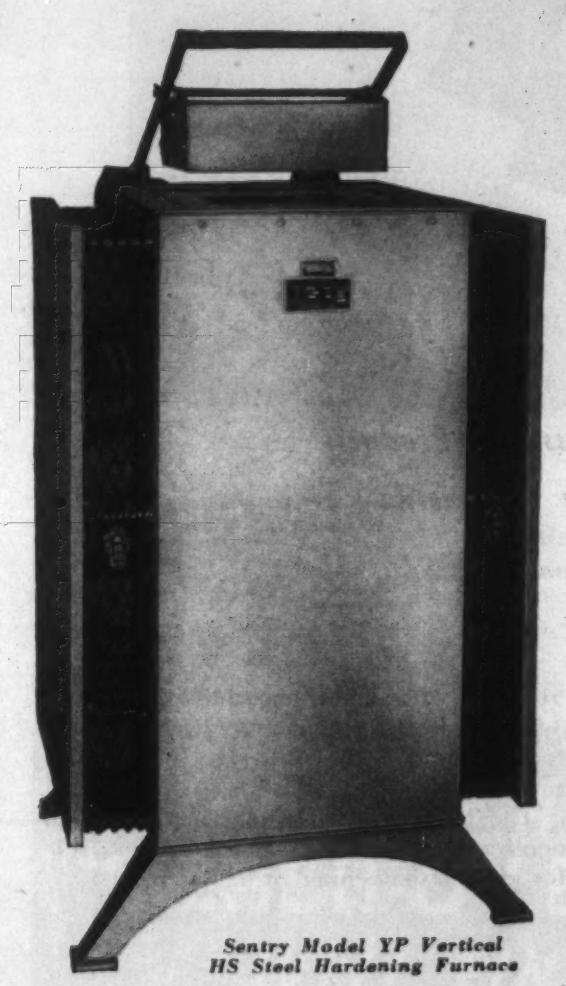
Table-Type Continuous Printers

Two table-type continuous printers that produce clear sharp blueprints or direct process black and white prints up to 44 in. wide at a speed up to 42 in. per min. have been developed by *Peck and Harvey*, 4327 Addison St., Chicago. They simply plug into any electric outlet. They print any length continuously without side travel, blurring or wrinkling.

The use of Cooper-Hewitt mercury vapor tube lamps, mounted horizontally, gives absolute uniform light intensity overall. Hand polished contact glass and sliding contact insure clear, clean overall exposure. A variable speed drive is included.



STRAIGHT! HARD! CLEAN!



Sentry Model YP Vertical HS Steel Hardening Furnace

Use a **Sentry Vertical H. S. Steel Hardening Furnace** and **The Sentry Diamond Block Method** to assure . . .

- **STRAIGHTNESS**
- **HARDNESS**
- **CLEANLINESS**

Designed especially for Long and Large tools that are best hardened in a Vertical Suspended Position. Three sizes, with tool capacities up to 4¾" Diameters and 36" Lengths.

Built for Sentry Diamond Blocks with Sentry Operating Economy . . . Sentry Speed of Heating . . . Sentry Reliability.

Bulletin 1023-3C Gives Details

The Sentry Company
FOXBORO, MASS., U.S.A.

Band Filing Machine

A new, low-cost continuous band filing machine, suitable for cleaning up or finishing materials previously sawed, nibbled, burned, stamped or cast, is brought out by *Continental Machines, Inc.*, 1301 Washington Ave. S, Minneapolis 4. It will do file

broaching on metals, alloys, plastics, fibres and wood. Providing for a continuous filing operation, it eliminates "back stoke" found in conventional reciprocal machine filing.

With it comparatively unskilled labor can get smooth finishes with tolerance of 0.001 in. Thousands of operations formerly done on expensive millers and broaches can now be performed on this DoAll band filer.

The maker claims it is nine times faster than hand filing and four times faster than by reciprocal band filing. There are 12 types and sizes of file bands, ranging from ¼ to ⅜ in. wide in ovals, half rounds or flats.

Internal filing is done easily by unsnapping the file bands and threading through the work.

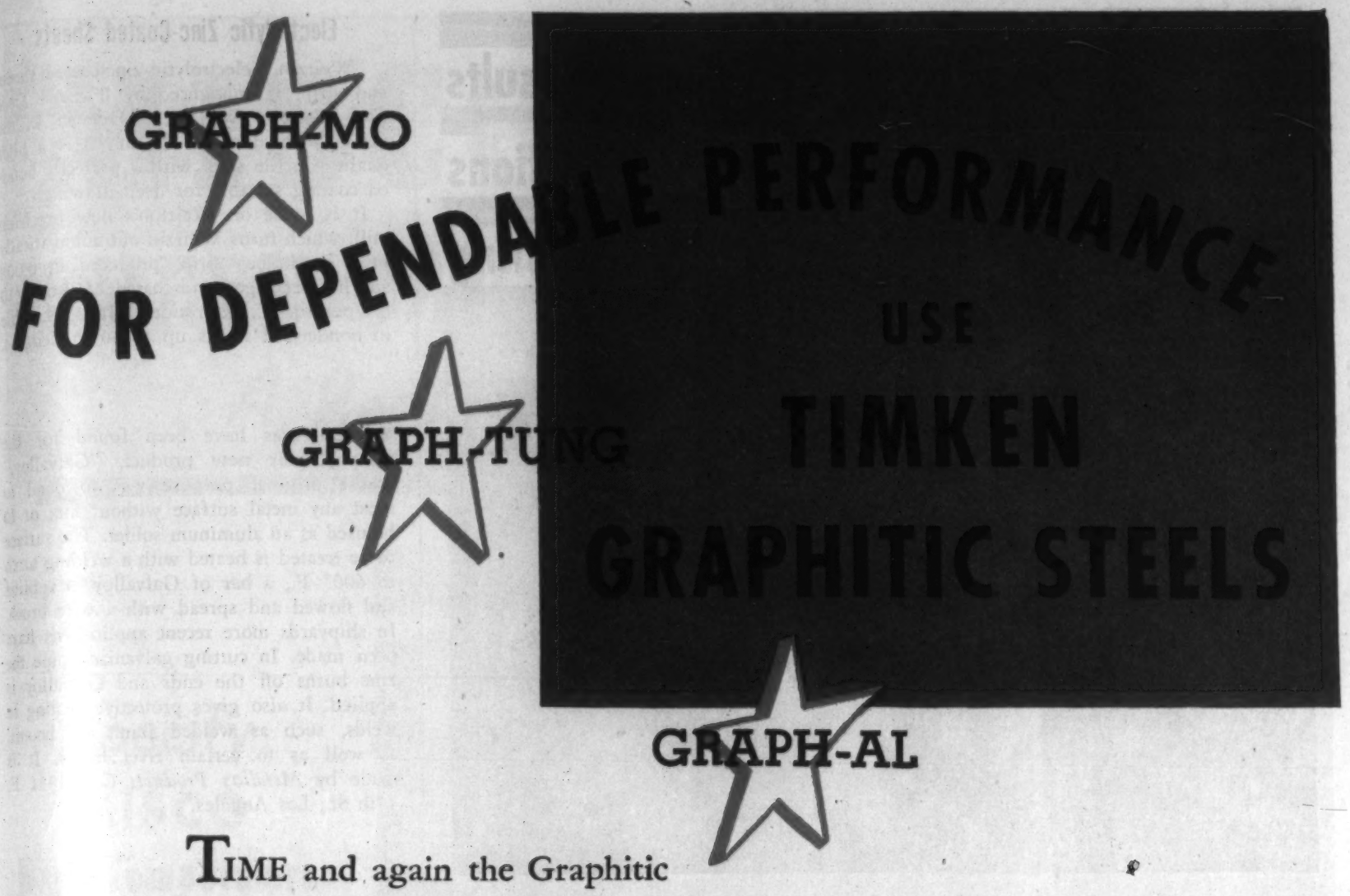
Spotlight for Arc Welders

A new spotlight designed to provide glareless illumination of sufficient intensity for an arc welder operator to see his work distinctly through the dark lens of a welding helmet prior to striking the arc is announced by the *Electric Welding Div., General Electric Co.*, Schenectady.

It is good for production line welding where the establishment of the arc must be made quickly and accurately, such as with thin materials, light alloy castings and aircraft parts. With it the operator does not need to lift his helmet before striking the arc.

The spotlight consists of three 300-watt reflector spot lamps surrounded by a circular shade, mounted on an upright telescoping metal standard and set in an 18½-in. diam., 30-lb. cast iron base. It rates at 1000 hrs. at 120 volts.

The area covered can be changed from a sharp spot, 7 in. diam., to a clover leaf pattern, 17 in. across.

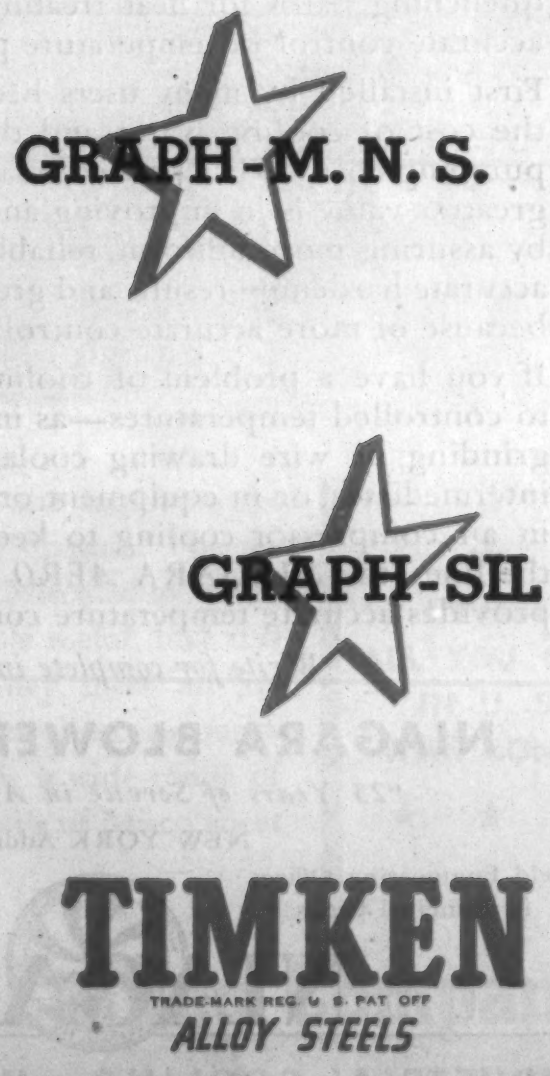


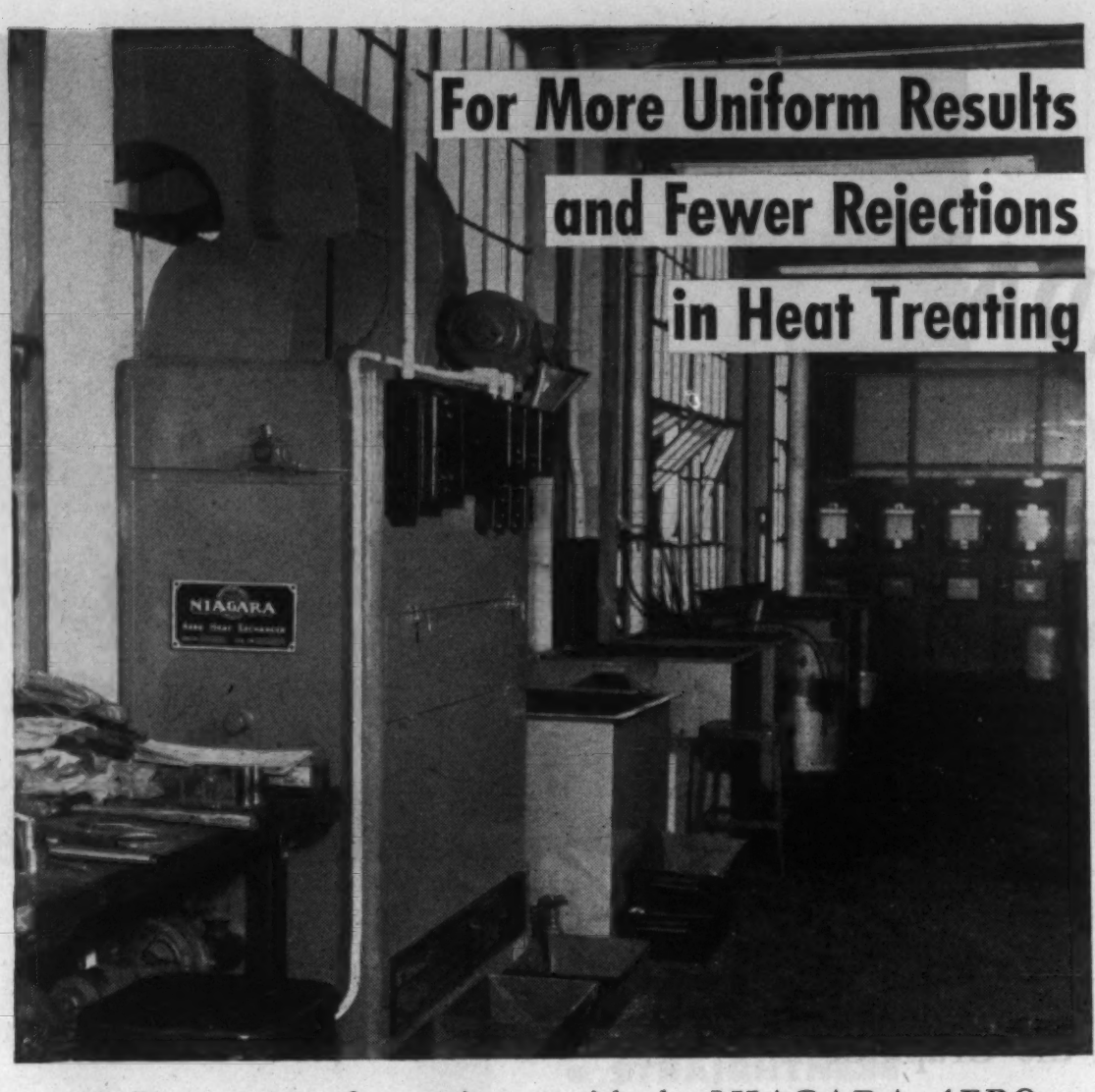
TIME and again the Graphitic Steels, by their dependable performance, have been the answer to the urgent demands of faster and greater production.

Reports from all along the production line state that they wear longer, have less tendency to score work and machine at least 25% faster than competing steels.

Each of these steels—Graph-Al, Graph-Mo, Graph-Sil, Graph-Tung, Graph-M.N.S.—are designed for specific jobs. If you will tell us the application you have in mind a Timken Engineer will be glad to recommend the proper steel.

A request written on your business letterhead will bring a 48-page booklet that is full of useful information about these five famous steels. Steel and Tube Division. The Timken Roller Bearing Company, Canton 6, Ohio.





For More Uniform Results and Fewer Rejections in Heat Treating

● Two years of experience with the NIAGARA *AERO* HEAT EXCHANGER as used to cool water and oil quenching baths for heat treating has proven that more accurate control of temperature pays extra dividends.

First installed by many users because it saved nearly all the cost of cooling water and the attendant piping and pumping costs, it has proved to these same users that its greatest value is in improving and increasing production by assuring more uniform, reliable operations, with more accurate hardening results and greatly decreased rejections because of more accurate control of temperatures.

If you have a problem of cooling any industrial liquid to controlled temperatures—as in quenching, machining, grinding or wire drawing coolants, or in chemicals or intermediates, or in equipment or engine jacket water, or in air compressor cooling to keep water and oil out of the lines, the NIAGARA *AERO* HEAT EXCHANGER provides accurate temperature control at lower cost.

Write for complete information

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Field Engineering Offices
in Principal Cities

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INDUSTRIAL COOLING • HEATING • DRYING
HUMIDIFYING • AIR ENGINEERING *EQUIPMENT*

Electrolytic Zinc-Coated Sheets

"Weirzin," electrolytic zinc-coated sheets and strip, is announced by *Weirton Steel Co.*, Weirton, W. Va. Made in widths of 32½ in. down to ⅜ in., it is a high quality ductile steel with a perfectly bonded coating suitable for deep drawing.

It is made on Weirton's new precision mill, which turns Weirzin out automatically in a continuous strip, produced in 0.008 and heavier gages, and coated 1/10 or 2/10 oz. per sq. ft., both sides. It is available in bonderized sheets up to 36 in. lengths.

● New uses have been found for the comparatively new product, "Galvalloy," whose original purpose was to bond to most any metal surface without flux or to be used as an aluminum solder. The surface to be treated is heated with a welding torch to 600° F., a bar of Galvalloy is applied and flowed and spread with a wire brush. In shipyards more recent applications have been made. In cutting galvanized pipe the zinc burns off the ends and Galvalloy is applied. It also gives protective coating to welds, such as welded joints on booms, as well as to certain rivet heads. It is made by *Metalloy Products Co.*, 1351 E. 17th St., Los Angeles.

Carbide Tool Grinders

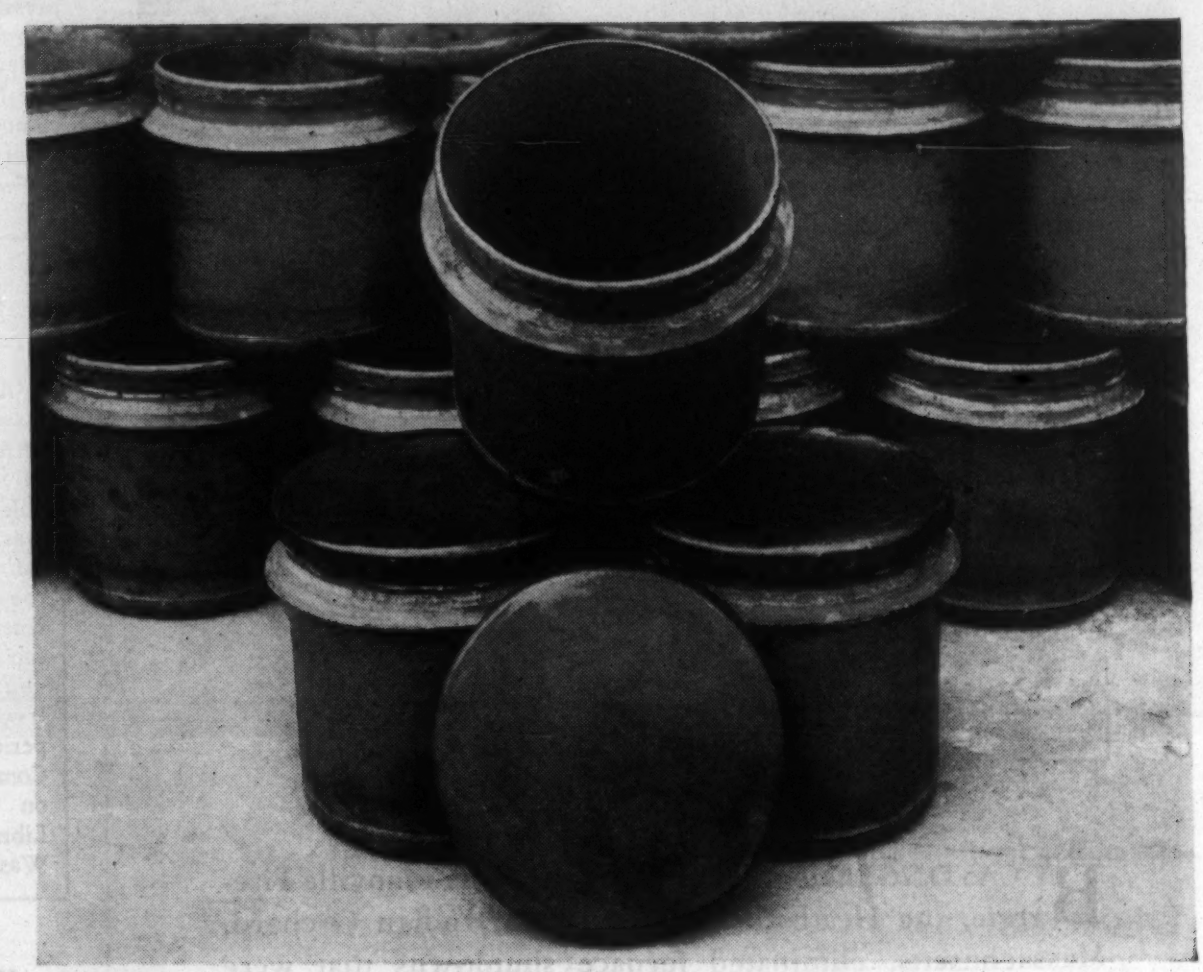
A newly designed line of 10- and 14-in. carbide tool grinders is announced by *Hammond Machinery Builders, Inc.*, 1646 Douglas Ave., Kalamazoo 54, Mich. A new coolant control feature facilitates properly flooding the tool while grinding wet.

Adjustable spouts with wide outlets permit correct flushing of the work by a slow, easy cascade of coolant without force. New large splash pans protect the operator, do not obstruct vision, enhance operating freedom and prevent splashing onto the floor.

A safety cup disc prevents the operator from dropping tools into the "well of the cup wheel." Wheel changes are made easier since the wheel guard hood is more easily removable. Water connections inside the hood are of flexible hose, hence the entire hood unit may be laid on top of the machine, exposing the wheel for easy access.

MISCO HIGH TEMPERATURE ALLOY SHEET CARBURIZING BOXES

A Real Aid to Production



Specify
MISCO
High Temperature Alloys for

Furnace Parts • Roller Rails • Conveyors • Roller Hearths • Conveyor Rolls • Trays • Retorts • Thermocouple Protection Tubes • Chain • Walking Beam Conveyors • Carburizing and Annealing Boxes • Dipping Baskets • Cyanide and Lead Pots • Centrifugal Castings and Miscellaneous Castings for use at high temperature or under corrosive conditions.

Misco sheet carburizing boxes are made by men who KNOW the requirements of carburizing containers and the conditions under which they operate. The result of this first hand specialized experience is the up-to-date Misco alloy sheet carburizing box. These modern, light weight boxes save valuable metal, fuel and space, and increase production by reducing heating time. They meet all accepted standards for efficient and economical operation. Misco sheet carburizing boxes are made in compact sizes and types that will handle a wide range of work with more production per box. We will gladly furnish details of Misco sheet carburizing boxes upon receipt of your inquiry.

★
INVEST ALL YOU CAN IN U. S. WAR BONDS
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MISCO
Heat and Corrosion Resistant Alloys

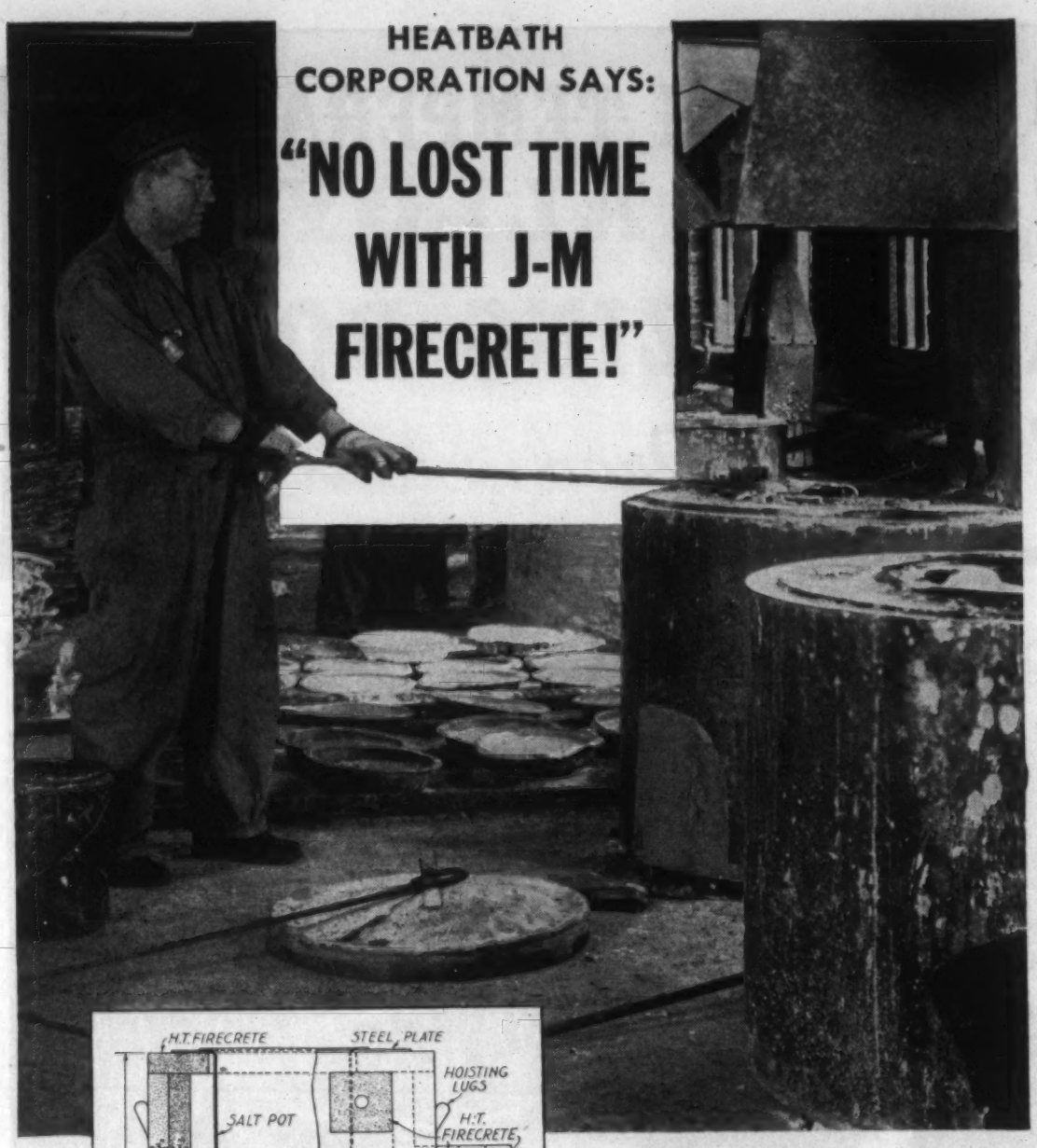
Michigan Steel Casting Company

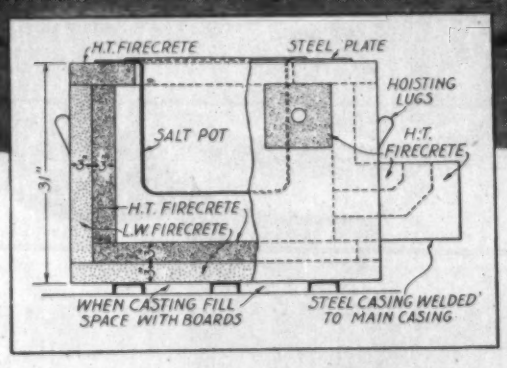
One of the World's Pioneer Producers of Heat and Corrosion Resistant Alloy Castings

1999 GUOIN STREET, DETROIT 7, MICHIGAN

HEATBATH CORPORATION SAYS:

"NO LOST TIME WITH J-M FIRECRETE!"





A battery of Heatbath furnaces made of J-M Firecrete.

This cross-section shows how 2 types of Firecrete were used by Heatbath engineers.

BY CASTING their own furnaces of Johns-Manville Firecrete, the Heatbath Corporation of Indian Orchard, Massachusetts, eliminated furnace shutdowns that were caused by waiting for delivery of special refractory shapes.

This costly shutdown problem was solved for this company because Firecrete can be cast as simply as ordinary concrete and then placed in service after 24 hours of air curing.

Three grades of Johns-Manville Firecrete are available—Standard Firecrete, 2400° F.; H.T. Firecrete, 2800° F.; L.W. Firecrete, 2200° F.

For complete details write for brochure RC-13A. Johns-Manville, 22 East 40th Street, New York 16, N. Y.

JM JOHNS-MANVILLE Firecrete
The Standard in Castables

Powder Metallurgy Press

A new high capacity press for powder metallurgy and dry pressing of ceramics, Model T-4, is announced by *F. J. Stokes Machine Co.*, Tabor Road, Olney P. O., Philadelphia 20. Pieces up to 2½ in. in diam. with a die-fill of 1⅝ in. are compressed 20 to 60 per min.

Pressures up to 12 tons are applied from both top and bottom, with adjustments possible while the machine is operating. Hence, the desired porosity in oil-impregnated bearings or the extreme density in a hard carbide tool bit is readily obtainable.

Features of this new T-4 press include separate ejection and compression levers; screw adjustment for compression; independent ejection cam; twin-disc clutch and combined brake that instantly starts and stops the machine, even under full compression load; variable-speed drive to obtain maximum production with materials and parts of varying characteristics and size; adjustable gibs to maintain close accuracy in punch and die alignment; and others.

Periodicals Wanted for Foreign Libraries

A committee of the American Library Association is collecting scientific and technical journals for eventual shipment to foreign libraries and institutions unable to get them now because of the war. The Committee is eager to acquire METALS AND ALLOYS because the publisher has no stock on hand for recent years. Only through your gifts can copies be obtained. *The Committee will provide storage space if necessary.* If you wish to help by donating your periodicals, please write to Dorothy J. Comins, Executive Assistant, Committee on Aid to Libraries in War Areas, Library of Congress Annex, Study 251, Washington 25, D. C.

Metal Bonded Diamond File, Hone

A metal bonded diamond file or hone with 100 concentration is now offered by *Diamond R. Agencies,* Pasadena 17, Calif. Called Diamond R. file, it has wearing qualities comparable to a metal bonded wheel over a resinoid bonded wheel. It will outwear five ordinary resinoid bonded hones, retaining correct surface, says the maker.

Being small, 6 x 1/4 x 3/16 in., it reaches formerly inaccessible places and eliminates costly set-ups. It will resharpen all tungsten carbide and high-speed steel tools; stone small radii on carbide tools without grinding, or large radii after grinding; dress short angles or small radii on abrasive wheels; take down high spots on dies after hardening, or hone lathe tools and remove chip build-up while in the machine.

The diamond grit is impregnated in metal to a depth of 0.10 in. on a surface, 1½ x ¼ in. Three grit diamond sizes are available.

Western Brass formerly used for pencils and dozens of other peacetime products is now going into vital propeller parts and numerous other wartime items. Tomorrow, when the full capacity of our mills at East Alton, Ill., and New Haven, Conn., is no longer needed for today's long list of military requirements, we will be ready to serve you. May we help you now with your post-war plans?

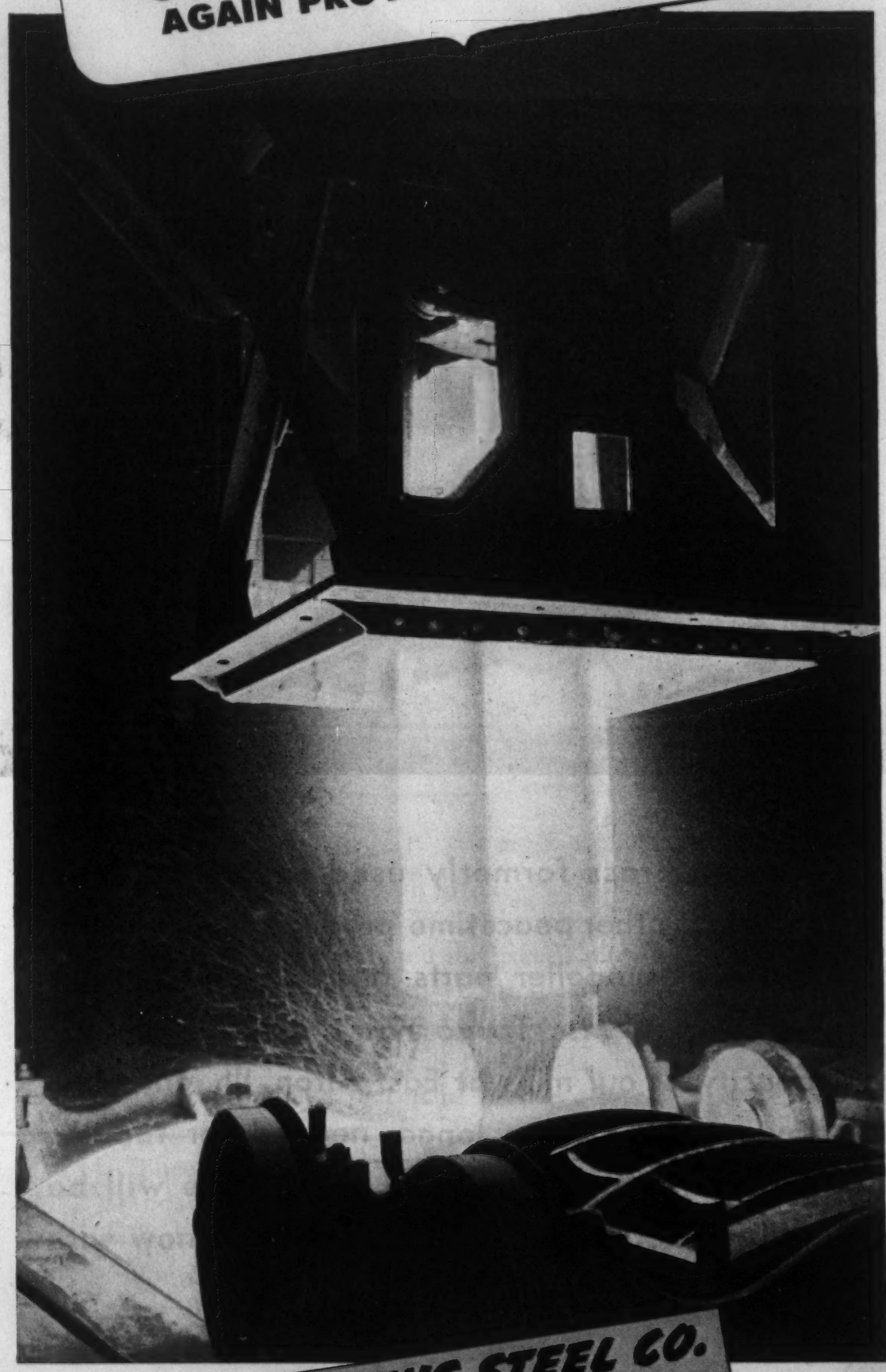
Western BRASS PRODUCTS
WESTERN CARTRIDGE COMPANY EAST ALTON, ILLINOIS, U.S.A.

Western BRASS MILLS

Division of WESTERN CARTRIDGE COMPANY, *East Alton, Ill.*

BRASS • BRONZE • PHOSPHOR BRONZE • NICKEL SILVER • COPPER

IN THE CRUCIBLE OF WAR,
Andrew Steel
AGAIN PROVES ITS HIGH QUALITY

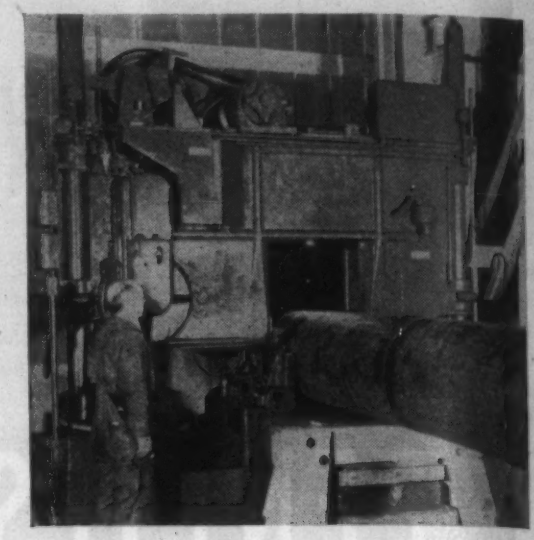


THE ANDREWS STEEL CO.
NEWPORT, KENTUCKY
DIVISIONS
THE NEWPORT ROLLING MILL COMPANY
THE GLOBE IRON ROOFING & CORRUGATING CO.
ANDREWS STEEL

BASIC OPEN HEARTH ALLOY STEEL BILLETS AND SLABS

Hack Saw Machine

Here's another "largest"—this time a hack saw that is shown in the photograph sawing an alloy shaft, 22 in. in diam. It is the No. 24 Marvel universal hydraulic roll-stroke hack saw machine in the plant of the *Mesta Machine Co.*, Pittsburgh, representing the latest developments in such



equipment. Maximum capacity is 25 in. x 26 in., weighs 16,000 lbs., and is 151 in. high.

It was designed to cut off or trim large billets, blocks and forgings fast and accurately, retaining advantages of the hack sawing method: Low initial cost, low tool cost, small chip loss, low power consumption, low maintenance and simplicity.

It uses a special blade 36 in. long, 4½ in. wide, ⅛ in. thick, with 2½ teeth per in. It has high-speed steel teeth and a tough alloy body.

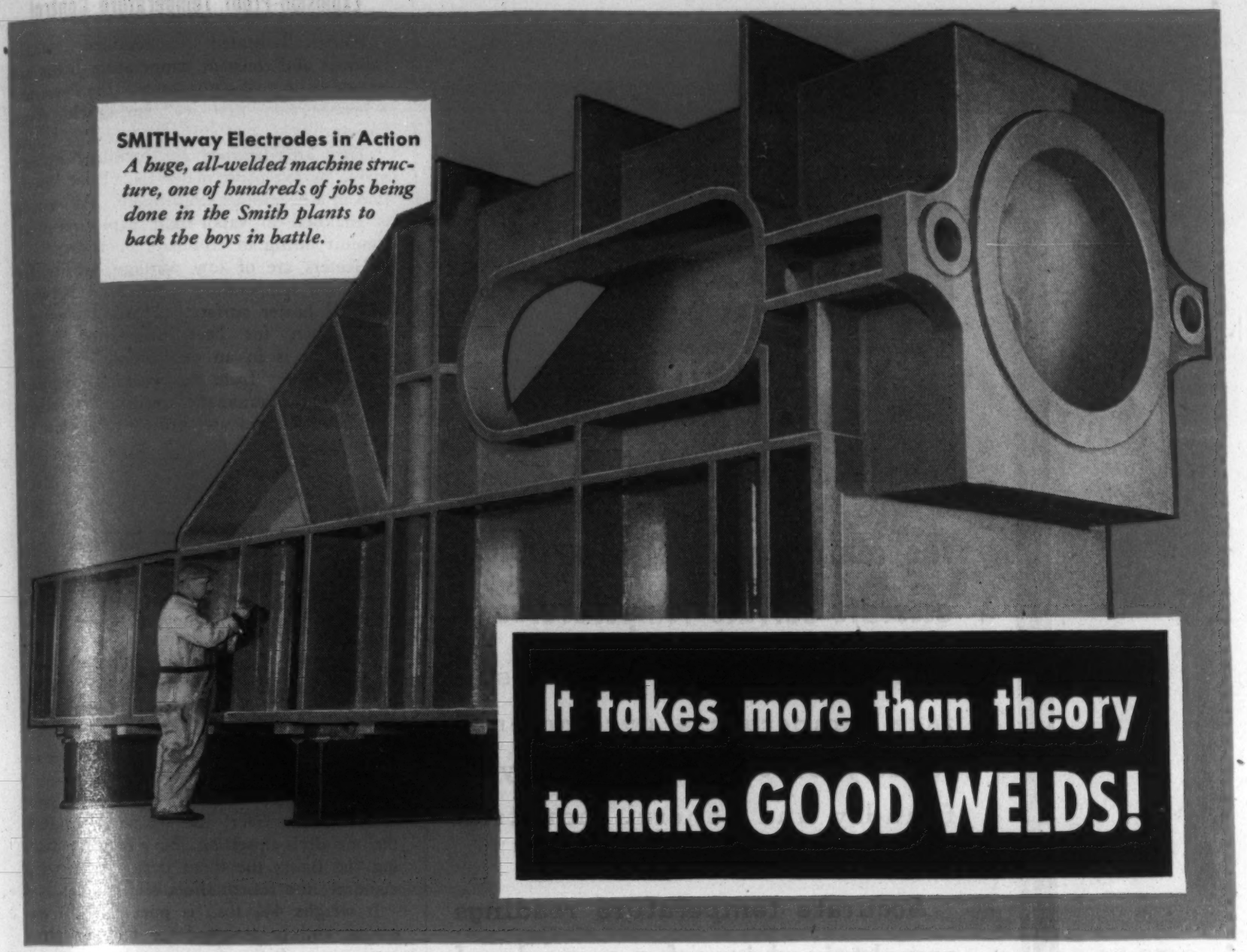
● What is claimed to be an entirely new type of metal cleaner and degreaser is a complex organic ester containing amide and sulphonate radicals, combining the action of an emulsifier and wetting agent. "Bonco No. 2," made by *Bonwit-International Co.*, 10 W. 33rd St., New York, gives effective action in 1 to 3 min. at 104° F. It is non-corrosive, and can be used on steel and brass parts.

Welding Positioner

A new 2500-lb. capacity welding positioner for production line, job work and maintenance welding has been brought out by *Harnischfeger Corp.*, 4460 W. National Ave., Milwaukee. Called model No. WP-2, it features flexibility of use, simplicity and ease of operation.

Construction is all-welded rolled steel, with 42 in. table, 18 handy radial slots for mounting fixtures, and turntable manually to suit welding speed. Tilting is controlled by hydraulic power with 135° beyond the horizontal position attainable. Both table movements have positive locking devices.

A telescopic column with self-locating stops provides for table elevation from 28 in. minimum to 60 in. maximum from floor. The removable table is held to the platen by ten heavy bolts.


SMITHway Electrodes in Action
A huge, all-welded machine structure, one of hundreds of jobs being done in the Smith plants to back the boys in battle.
It takes more than theory to make GOOD WELDS!

Theory has an important place in the development of any welding electrode. But theory only means something to you after it has been *proved in the shop.*

Right there you have the difference between SMITHway Certified Welding Electrodes and the run-of-the-mine variety.

We may *start* the development of an electrode on a theory—but *we don't stop there.* After the theory . . . after the research work . . . after the laboratory tests—then comes the showdown! The electrode goes out into our welding shops. There it is put through its paces *under actual shop conditions.* If it proves successful there, it has what it takes to prove up anywhere!

That is the kind of electrode we offer you in *SMITHway Certified Welding Electrodes.* There's theory back of them. There's scientific laboratory research and testing back of them. But best of all —they're *shop-tested* because what we want from an electrode is *better welds.*

That's what you want, too—isn't it?

Mild Steel...High Tensile...and Stainless Steel
WELDING ELECTRODES

made by welders . . . for welders

SMITHway Welding Monitor *cuts time cost of training welders as much as 33⅓%!*

SMITHway AC Welding Machine *—no arc blow; reduces spatter losses; saves power.*

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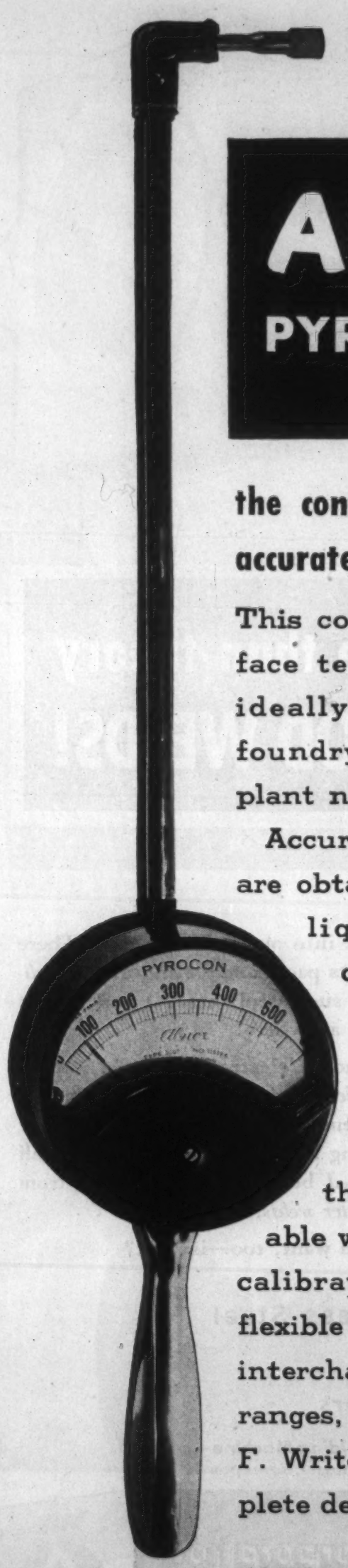

Alnor
PYROCON

the contact pyrometer for quick, accurate surface temperatures

This convenient all-purpose surface temperature pyrometer is ideally suited to a variety of foundry and general industrial plant needs.

Accurate temperature readings are obtained in a few seconds, of liquids, oils, and flat or curved, stationary or moving surfaces. The rugged shock-resisting Pyrocon movement is used with any one of eleven types of thermocouples, interchangeable without adjustment or recalibration. Choice of rigid or flexible arms, or both, instantly interchangeable. Built in several ranges, 0-300 deg. F. to 0-2000 deg. F. Write for bulletin giving complete description.

ILLINOIS TESTING LABORATORIES, INC.
425 N. La Salle Street, Chicago 10, Illinois

Explosion-Proof Temperature Control

Electrically-heated temperature control cabinets and constant temperature baths are extended lines of equipment of the *Precision Scientific Co.*, 1750 N. Springfield Ave., Chicago 47.

They are designed for handling inflammable or explosive materials, or for operation in a hazardous atmosphere. All wiring is enclosed in vapor-tight explosion-proof conduit fitting to eliminate open arcs.

Heaters are of low wattage density for minimum temperature differential between air and heater surface. Heating elements are ribbon for heat dissipation. The thermostat is in an explosion-proof metal housing, away from the working chamber. Doors allow automatic opening to release internal pressures and breaking of contacts when open.

Rapid Blind Rivet Driver

A new device that will drive four blind rivets a minute into aircraft, working 6 to 8 times faster than previous methods, is announced by *Independent Pneumatic Tool Co.*, 600 W. Jackson Blvd., Chicago 7.

Known as the Thor "Riv-Driver," it operates in a fast 4-step cycle and features a light at the top of the handle that flashes "O.K." when accurate upsetting is done on the blind side.

The first step in the cycle screws a mandrel into the rivet; the second pulls back the mandrel, upsetting the rivet and flashing the light; the third step unscrews the mandrel; the fourth shuts off the tool.

It weighs 4¼ lbs., is pneumatically operated, and is designed for finished plane sections to which are connected de-icers, instrument panels and other light assemblies.

Alloy and Flux for Magnesium Welding

A new improved welding procedure, rod and flux for magnesium alloy castings, is announced by *Eutectic Welding Alloys Co.*, 40 Worth St., New York. It is used for filling and adding metal on castings and parts that are broken, cracked, porous, etc.; or for joining magnesium sheets to castings or correcting machining errors.

Known as Castolin Eutectic Alloy No. 1900, it gives welds that contain a very high amount of magnesium and aluminum, therefore closely matching the parent metal. Resulting tensile strength is 29,000 p.s.i., and binding temperature is 960 to 1060° F.

SOMETHING EVERY ENGINEER SHOULD HAVE!

—and that something is these two books:

1. **"The Fabrication of Republic ENDURO Stainless Steel"**
2. **"The Welding of Republic ENDURO Stainless Steel"**

Both books are filled from cover to cover with production-boosting, money-saving suggestions on how to work and weld stainless steel on a production basis.

Along with this helpful information taken from the actual experience of men who know, you will find many useful tables to assist you in your work.

These informative books have been of inestimable value to thousands of fabricators. If you work stainless steel you should have them for ready reference.

Either or both books will be sent promptly—if you will request them *on your business letterhead.*

REPUBLIC STEEL CORPORATION
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Sales Offices • Massillon, Ohio

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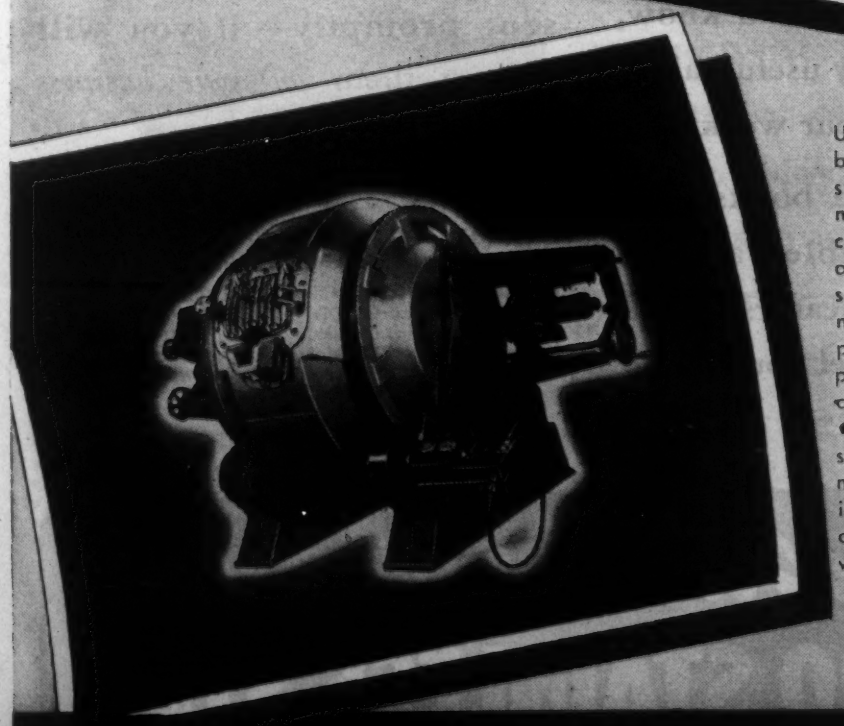
Republic
ENDURO STAINLESS STEEL
Reg. U. S. Pat. Off.

Other Republic products include Carbon, Alloy and "Quality" Steels—Pipe, Sheets, Strip, Plates, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

Rapid melting—less rejects with Detroit Electric Furnaces

Faster melting — more heats per day —lower metal losses — less labor — more pounds produced per man hour—absence of dust, fumes, fuel and hard work — these are attributes of the Detroit Rocking Electric Furnace in the foundry.

A high percentage yield of perfect castings, uniform quality, improved machineability and thus lower fabricating costs — these are some of the overall economies resulting from the use of the Detroit Furnace.



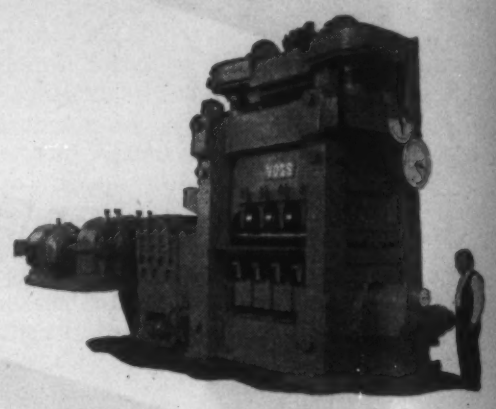
Used for brass and bronze, iron and steel, nickel, monel metal and many special alloys—There is a Detroit Furnace to suit every foundry need — from 10 pounds to 8000 pounds molten metal capacity per heat. • Since 1918—the standard foundry melting unit — used in hundreds of foundries throughout the world.

DETROIT ELECTRIC FURNACE DIVISION

KUHLMAN ELECTRIC COMPANY • BAY CITY, MICHIGAN

Armor Plate Leveler

An armor plate leveler, the largest and heaviest of its type ever built, has been completed by *Voss Machinery Co.*, 2898 W. Liberty Ave., Pittsburgh 16.



Designed by the Voss engineering department, it has all the features of the former machines, but includes recent developments and patents.

Aluminum Alloy for Aircraft Surfaces

A new aluminum alloy product for use on exposed surfaces of airplanes, designated as R-301, has been brought out by *Reynolds Metals Co.*, Federal Reserve Bldg., Richmond, Va. It consists of a high strength core alloy covered on each face with a corrosion-resistant intermediate strength alloy.

Elements are the same as in the common 24-S alloy: Aluminum, silicon, iron, copper, manganese and magnesium; hence, inadvertent mixing of the two scraps is not serious.

Unlike the 24-S alloy, R-301 can be formed, hammered, rolled or drawn and then solution heat-treated for maximum tensile properties in the hardened condition, with minimum yield strength 46% higher.

● Oxidine black finishes and the Jetal process have been improved by the *Alrose Chemical Co.*, 180 Mill St., Cranston, R. I. For brass and copper Oxidine B is an excellent adhering hard black. For zinc, Oxidine Z gives a durable velvety-smooth adherent black. On cast iron, Oxidine CI obtains a dense black finish at low temperature. For steel, the Jetal process is ideal as an immersion black finish.

Resin for Armor Steel Castings

Faced with a scarcity of the specially-graded silica sand used in cores and molds to shape cast armor steel for combat vehicles, foundries have greatly increased their use of mechanically reclaimed old sand by mixing it with pulverized resin. Thus, one foundry has cut its new sand requirements from 2,500 tons to 600 tons monthly.

Chemists of the *Hercules Powder Co.*, Wilmington, Del., extract the resin from Southern pine wood. The resin binds the sand grains together to form the core. "Truline binder," the Hercules resin, also provides unusual dimensional accuracy in the sand shapes for casting steel parts on tanks, tank busters, jeeps, weapon carriers, etc. In peace-time it was used for railway and industrial steel castings.

NOW THAT ZINC HAS SO MANY MORE WAR JOBS TO DO . . .

its ANOZINC*

ANODIZED

for increased corrosion resistance

Have you switched from other metals to steel and zinc plating? Or from cadmium to zinc plating? Do you find it necessary to meet the requirements of specification AN-P-32, Revision 2? Then you will want to investigate ANOZINC!

With this treatment, you can increase the corrosion resistance of zinc plated on steel or other metals – get a more attractive finish as well. In fact, you can make a zinc plated finish suitable for countless applications where outdoor exposure, corrosion and handling are encountered.

Here in a nutshell is what ANOZINC offers.

A fast, inexpensive method of producing by anodic treatment, an attractive, resistant coating on zinc plating and certain zinc base die castings.

For countless parts now being plated or black finished, this treatment will mean improved appearance as well as longer service life. Parts finished in ANOZINC baths have stood up in excess of 200 hours under the Army-Navy salt spray test AN-QQ-S-91.

Two attractive finishes are available—a dark semi-lustrous black, and a brassy, slightly iridescent yellow—a different bath being used for each color.

Existing plating facilities in most cases, can be readily converted for use with this process. The constituents of ANOZINC baths are stable and can be easily controlled by any competent plater. The salts are inexpensive and no license agreement need be executed.

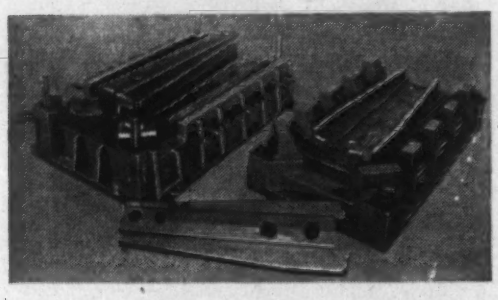
For further information write to the nearest office below, indicating the size, quantity and nature of the parts to be treated, the basic metal and type of zinc plating used. Your inquiry will receive immediate attention.

☆ *Trade-mark Reg. U. S. Pat. Off.*

UNITED CHROMIUM
INCORPORATED
51 East 42nd Street, New York 17, N. Y.
Waterbury, Conn. ☆ Detroit, Mich.

YOU CAN'T ESCAPE THE IMPORTANCE OF THESE FIGURES

Tractor top die (75% Strenes metal) 33⅓% less costly than like die of conventional metals. Weight 17,000 lbs. More than 500 hours of machining time, saved because the collapsible die, pressure pad, and cam blocks were so closely cast to shape. Important saving in raw stock also reported.



Tractor Top Die, 75% Strenes Metal

At the best, any tooling program runs into money. All the greater reason for using the most effective materials and saving time and money wherever possible. We make many and strong claims for Strenes metals, but can support them. Challenge us.

Automobile, truck, tractor and farm implement manufacturers.

Refrigerator, stove, and metal furniture manufacturers.

Casket and vault manufacturers.

Fan, blower, bicycle, vacuum cleaner and scores of other products involving sizeable forming and drawing operations.

Today while it is on your mind, investigate Strenes Metal.

THE ADVANCE FOUNDRY CO.

100 PARNELL ST.

DAYTON, OHIO

STRENES METAL

News of Men, Societies, Meetings and Companies

Plants and Slants

The one-millionth steel cartridge case made by the *Norris Stamping & Mfg. Co.*, Los Angeles, was recently presented with appropriate ceremony to Lieut.-Gen. William T. Knudsen, who is in charge of all industrial production for the U. S. Armies. The Norris people claim that the steel cartridge cases fabricated in their plant were the first to be successfully produced in America. Originally, too, the Navy used aluminum cartridge containers, but Norris devised a method of switching from aluminum to steel, resulting in one-piece containers that were air- and water-tight and otherwise satisfactory.

Charles Lukens Huston, pioneer steel master and first vice president, *Lukens Steel Co.*, recently celebrated the 68th anniversary of his first day's work as a clerk for that company in 1875. He still comes to the office every day, and inspects the mills several times weekly. He is a patentee of several highly regarded inventions in the manufacture of steel, and is the author of several monographs and books on related subjects. He planned and designed the Lukens 4-high 206 in. plate mill, the largest in the world.

The editorial service department of the *Westinghouse Electric & Mfg. Co.* has a new address, 306 Fourth Ave., P. O. Box 1017, Pittsburgh 30, Pa.

The *Titeflex Metal Hose Co.*, Newark, N. J., has changed its corporate name to *Titeflex, Inc.* because its original name was no longer descriptive of the products made by the company.

The *Hydro-Arc Furnace Corp.*, La Grange, Ill., has been acquired by *Whiting Corp.*, Harvey, Ill. W. Harvey Payne, president of Hydro-Arc, will serve as consulting engineer for Whiting on electric furnace projects. A. W. Gregg, executive engineer of Whiting's foundry equipment div., will be in charge of the electric furnace department.

The business of the *Gehnrich Corp.*, Long Island City, N. Y., for over 60 years pioneers in the development and building of industrial ovens, dryers and air heaters, has been purchased by *W. S. Rockwell Co.*, 50 Church St., New York 7, and is being operated as *Gehnrich Oven Div.* of the latter company. The engineering, manufacturing and sales personnel of the old firm will be retained.

The Cleveland office and factory of the *Claud S. Gordon Co.* are now located at 7016 Euclid Avenue., the new quarters more than doubling their previous space, with considerable increase in manufacturing, repairing and servicing capacity.

The *Corrosion Control Corp.*, Norwalk, Conn., changed its corporate name, as of Jan. 1, to *Cordo Chemical Corp.* The change was made to better fit the new products, such as industrial coatings, finishes, lacquers and bonding adhesives.

The No. 2 blast furnace of the *National Tube Co.* at Lorain, Ohio, closed down Dec. 23, after having operated continuously since 1937, producing 24,000 tons of pig iron monthly. Decline in orders for pig iron was the immediate reason for the shut-down. Meanwhile the furnace will be relined and held in readiness for restarting.

Certain departments of three Philips companies jointly occupied the fourth floor of the Pershing Square Bldg., 100 E. 42nd St., New York 17, on Jan. 1. The companies involved are *North American Philips Co., Inc.*, *Philips Metalix Corp.* and *Philips Export Corp.*

Timken Roller Bearing Co. announces that the *Peninsular Steel Co.*, Cleveland, will expand their activity in Ohio for the distribution of graphitic tool steels, the added territory including Dayton and Cincinnati.

Acquisition of the *Crown Spray Gun Mfg. Co.* of Los Angeles by the *Kellogg Div., American Brake Shoe Co.*, is announced. Crown makes a broad range of spray guns and paint spray equipment, including industrial spray guns, booths, exhaust fans and paint containers. By now Brake Shoe operates 59 factories.

Announcement is made of the formation of *Mec-Rad Div.* of *Black Industries*, 1400 E. 222nd St., Cleveland, to manufacture the mechanical components of all types of radionic devices.

An exhibit of "Art in Industry," designed to show some of the aesthetic values of the machine age, opened Jan. 4 at the Museum in Rockefeller Center, New York. Murals, posters, water colors, photographs, and metal sculpture were displayed by the sponsor, *Bridgeport Brass Co.* The paintings were done originally to help employees of the company to see their part in the war effort. A series of four murals, representing planes, tanks, guns and ships, was done by Kerr Eby, and first exhibited at the factory.

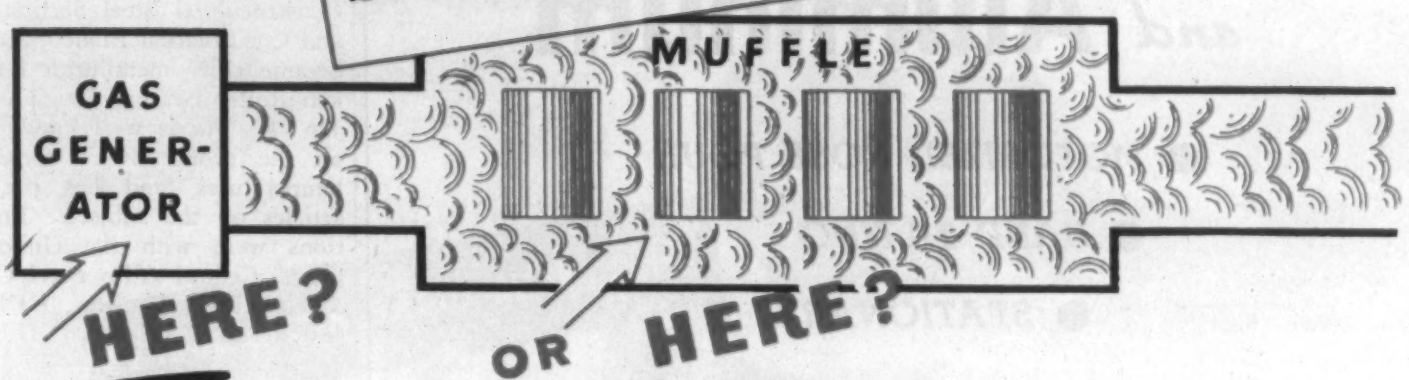
News of Engineers

Dr. Harvey N. Davis, president of Stevens Institute of Technology and director of the office of production research and development, WPB, has been elected honorary member, Institution of Mechanical Engineers in England, the fourth living American to be so honored.

George L. Craig has been appointed director of research, Calumet & Hecla Consolidated Copper Co. He joined that organization in 1934, having previously been in research work with Battelle Memorial Institute.

Marvin G. Sedam has been appointed

How far would you say that CONTROL should extend?



There is only ONE answer . . .

RIGHT INTO THE MUFFLE AT THE WORK!

This control at the work is exclusive with

LITHIUM

METALLIC VAPOR

ATMOSPHERE FURNACES

Any atmosphere becomes contaminated the moment it enters the muffle. Water forms from inter-gaseous reactions . . . air and water vapor enter through the door . . . and are present on the metal. Neither can be kept out . . . both destroy the surface and sub-surface of the metal.

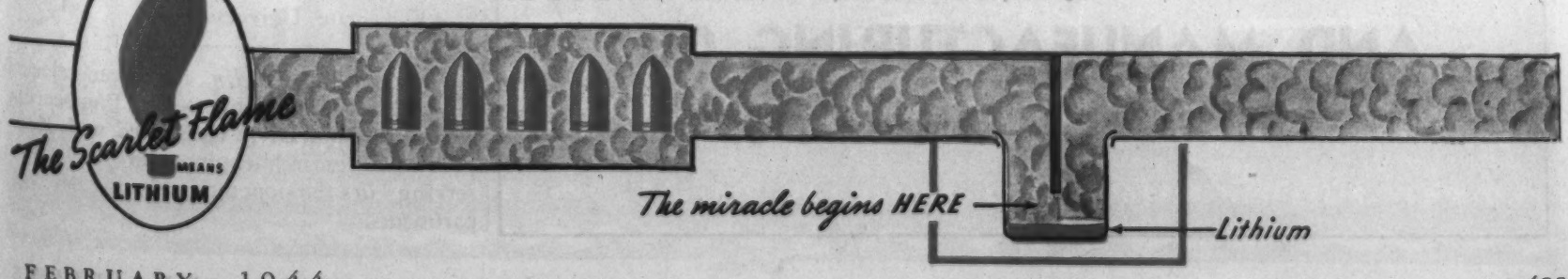
In a Lithium atmosphere, these troublesome elements are neutralized immediately. Control extends not only into the muffle but to the instant of quenching or even during cooling in air. The atmosphere becomes truly inert and remains inert without costly controls and attendance.

Lithium Furnaces are: LITHCO for heat treating; LITHCARB for bright carburizing.
Both control at the work

THE LITHIUM COMPANY

Manufacturers of Atmosphere Furnaces
111 SYLVAN AVENUE, NEWARK, N. J.

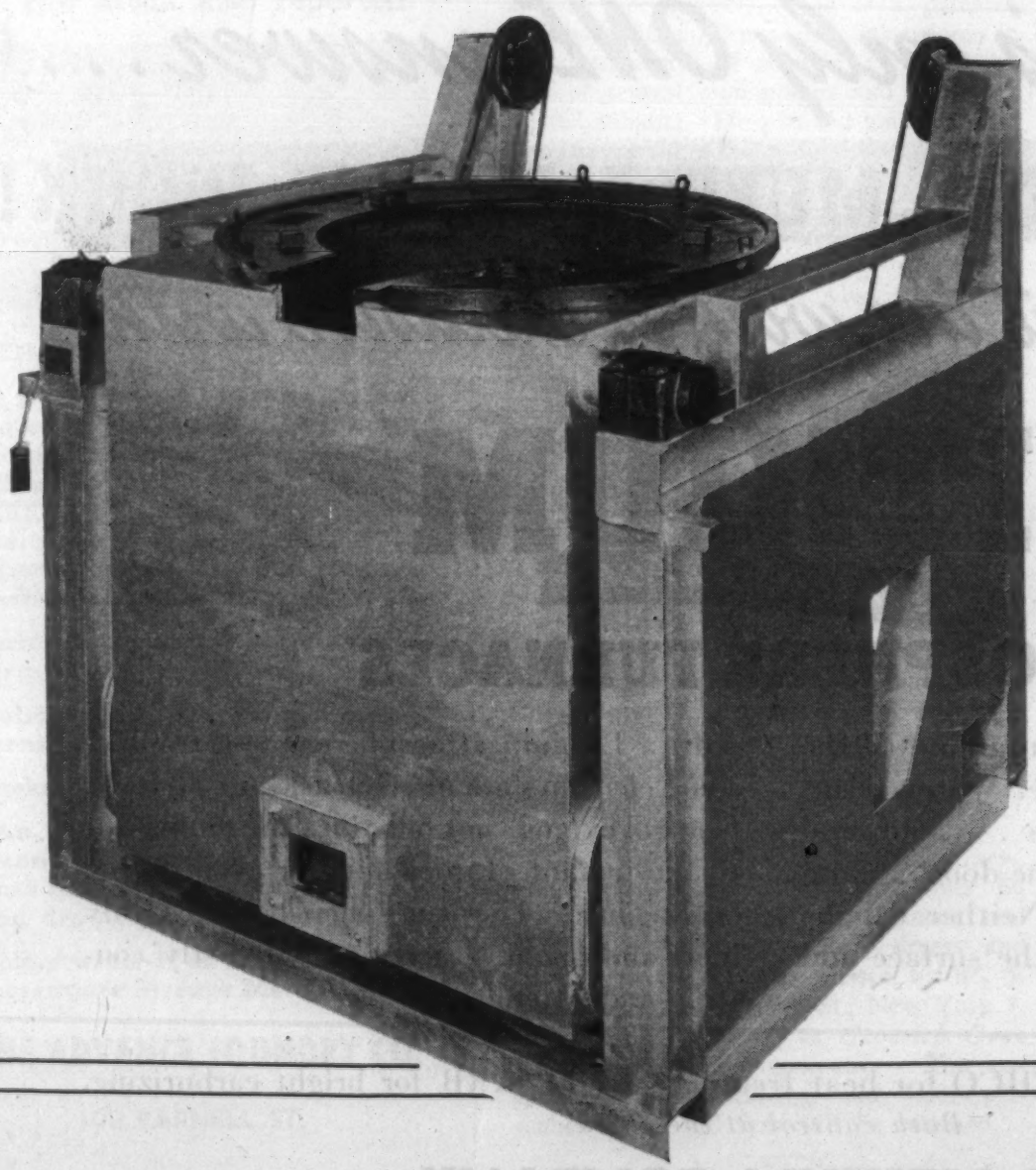
The Scarlet Flame means LITHIUM



MONARCH FURNACES

for Magnesium *and* Aluminum

- *MOTORIZED NOSE POUR*
- *HAND TILTING*
- *STATIONARY*



THE MONARCH ENGINEERING AND MANUFACTURING CO.

Curtis Bay Baltimore, Md.

director of research for the Alloy Rod Co., York, Pa., maker of stainless steel electrodes. He was formerly with Harnischfeger Corp., Milwaukee, as chief metallurgist in charge of welding rod research and development.

L. D. Granger, well known steel metallurgist and engineer, has been elected vice president, American Wire Fabrics Corp., subsidiary of the Wickwire Spencer Steel Co.

Ralph L. Wilson, former chief of the Constructional Steel Section, Metallurgical and Conservation Branch, Steel Div., WPB, became chief metallurgical engineer, Timken Roller Bearing Co., Canton, Ohio, on Jan. 1. He is well known for his work on the properties of metals at elevated temperatures, and has contributed many articles on the subject. Previous connections were with the United Alloy Steel Corp., Central Alloy Steel Corp. and Steel & Tube Div., Timken. He belongs to several technical societies.

Leighton M. Long, formerly chief metallurgist and foundry superintendent of the Bunting Brass & Bronze Co., Toledo, Ohio, has been named assistant research supervisor at Battelle Memorial Institute, Columbus. He entered the metallurgical field in 1922 when he joined the Bohn Aluminum & Brass Co., Detroit. He is an active officer and committeeman in several technical societies.

William E. Curran has been made vice president in charge of manufacturing of the Rheem Mfg. Co. and general manager of the company's eastern division. Prior to joining Rheem in 1942, he served 18 years as general superintendent, Birmingham plant, Republic Steel Corp.

E. C. Ostlund has been appointed assistant chief industrial engineer, American Steel & Wire Co., with offices in Cleveland. He has been with the company since October, 1936, when he was made industrial engineer at Worcester, Mass. *Evarts C. Hall* has been named works industrial engineer at South Works, Worcester, to succeed Mr. Ostlund, having joined the company in November 1936.

Victor R. Willoughby has been made director of research and development, American Car & Foundry Co., having formerly been in charge of engineering. He is being succeeded in his former position by *Edmund D. Campbell,* formerly general mechanical engineer and now vice president in charge of engineering.

Charles D. Young, chemical engineer, has been appointed to the research staff of Battelle Memorial Institute, Columbus, division of non-ferrous metallurgy. Previously he was an assistant in chemistry at Ohio State University.

George M. Carvlin has been elected vice president of Koppers Co., Engineering & Construction Div. He started with Koppers as a research engineer in 1925, later serving in the operating and sales departments.

Such iron castings can now be pre-checked for machinability with the

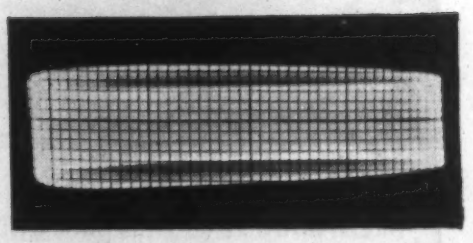
DuMONT *Cyclograph*

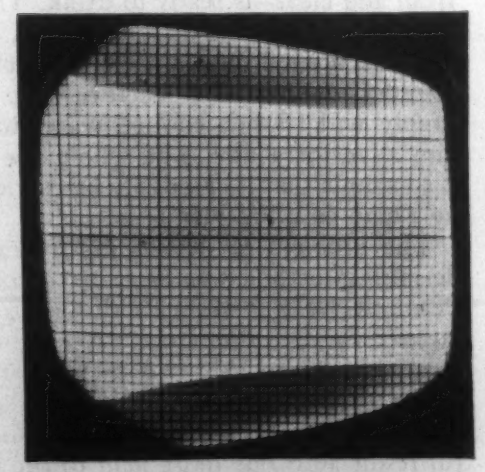
Have you ever had the problem of sorting malleable iron from cast iron? Or again, have you had malleablized castings rejected because they could not be machined?

You can now avoid such experiences. The Du Mont Cyclograph provides a positive, economical, *non-destructive* check for machinability. Either visually or automatically, this instrument sorts castings. Saves countless man-hours; eliminates costly delays; speeds up production flow.

The Du Mont Cyclograph also distinguishes between analyses of iron and other metals and alloys. Identifies structures in steels. Checks case depth, decarburization, plating or cladding, size, internal stresses, etc.

The Du Mont Cyclograph is available on a rental basis. Write for descriptive literature and terms.





These high-frequency patterns, or cyclograms, distinguish at a glance between malleablized and cast-iron pieces. The Cyclograph is readily operated by factory worker or technician, for desired data. In another form the Cyclograph sorts pieces automatically according to desired standards or tolerances.

DUMONT *Precision Electronics & Television*

ALLEN B. DUMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • CABLE ADDRESS: WESPEXLIN, NEW YORK

How to drink sea water ...AND LIVE!

FORCED down at sea, this pilot will live to fly and fight again, because thirst—age-old enemy of shipwrecked men—has been conquered. Now he can drink sea water!

Packed with his deflated life-raft, the flyer carries a compact Permutit Sea-water Desalting Kit. Adrift, he simply scoops up sea water in a plastic bag, drops in a small briquet and in a few minutes the water—fresh and clear—is ready to drink. The briquet precipitates the dissolved salts, which are then filtered out as the flyer sucks the water through a tube. Each briquet in his supply will freshen enough water to keep him alive for a day. The whole operation is so simple that it can easily be carried out by a man on a life-raft.

The problem of developing a practical de-salting method was early recognized by Permutit. Here at water conditioning headquarters, chemical engineers worked intensively on it for months and the final product was acceptable to the U.S. Navy, Army and Air Transport Command. The successful result adds one more field to the many in which Permutit's long experience in water treatment is serving our country at war. The Permutit Co., Dept. A17, 330 West 42nd St., New York 18, N. Y. In Canada: Permutit Co. of Canada, Ltd., Montreal.

PERMUTIT

WATER CONDITIONING HEADQUARTERS

Robert Murray has been appointed assistant division metallurgist at Cleveland for the American Steel & Wire Co. Educated at Glasgow Technical College, he joined the wire company in 1920, as sample clerk, working up through the ranks. *Edwin E. Caspell* has been made superintendent of the New Haven works, succeeding Mr. Murray. *Arvin P. Wiedemann* has been made general foreman of the rope mill there.

G. J. Stegemerten, staff supervisor of industrial methods engineering, Westinghouse, is named expert consultant to the Secretary of War. He will study arsenals and ordnance plants as to administrative functions. He has written books and magazine articles on time and motion study and wage incentive procedures.

L. V. Tuttle has been made foundry manager of Gisholt Machine Co., Madison, Wis., having been with the Koehring Co., Milwaukee, in a similar capacity for the past 12 years.

Donald S. Klippert has been made assistant general manager of sales, Timken Steel & Tube Div., Canton, Ohio. He spent two years as chief metallurgist, White Motor Car Co., Cleveland, and for six years prior to that was in charge of metallurgy for Lycoming Div., Aviation Mfg. Corp.

Briefs on Associations, Promotions, Education

Membership in the Gray Iron Founders' Society in December was at a new record high of 739 foundries in 42 states and Hawaii, states W. W. Rose, executive vice president. This is a net gain of 111 during the past year.

The post-war steel industry will not be seriously menaced by aluminum, magnesium or plastics, states Dr. John M. Weiss, New York industrial chemist, to the American Chemical Society. "Competition from light metals and new needs may so stimulate the alloy steels as actually to increase production and thereby bulwark the steel manufacturers. The steel industry cannot be expected to surrender tamely to light metals, even to the extent of 2%. The light metals will have to justify their entrance into some broader line than transportation, such as building and structures, where a small proportion of the total tonnage would afford substantial outlets."

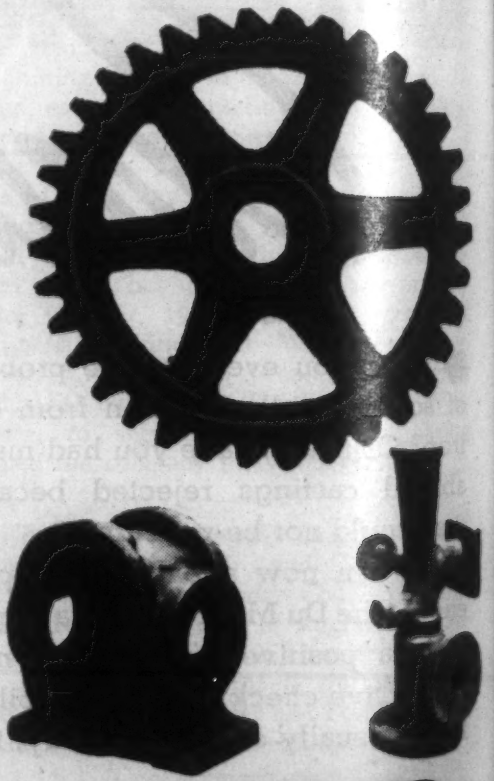
Formation of a National Association of Cutting Tool Manufacturers was voted at Detroit in December by 150 representatives of 100 manufacturers of cutting tools, who registered as "temporary members" pending formation of an association. Among immediate objects are assistance on renegotiation, contract cancellation, disposal of surplus tools, standardization, etc. It will not be concerned with prices or marketing of tools.

The American Standards Assn. has published its new list of standards, listing more

Higher Corrosion Resistance in these STAINLESS STEEL CASTINGS

The casting of alloy steels is an art. Atlas metallurgists having pioneered the casting of stainless alloy steels, are thoroughly familiar with the intricacies involved. All stainless steel castings must be designed for the particular job. Therefore when a casting is in the blueprint stage, Atlas metallurgists can save much redesigning if consulted at once. There is no obligation for this valuable service. Your inquiries are invited.

Write for Illustrated Bulletin



ATLAS
STAINLESS STEEL CASTINGS

Division Atlas Foundry Co.
520 LYONS AVE. IRVINGTON, N.J.

NEW FREE BOOK tells how to keep fire-fighting equipment in shape

When fire strikes at your plant — will your extinguishing equipment be *ready?* A clogged nozzle, a cylinder not fully charged — these and dozens of other results of negligence can make your fire-fighters useless when you need them most. Regular, systematic inspection is the only way to make sure your equipment's in fighting trim.

To help you set up a maintenance system in your organization, Walter Kidde & Company has prepared a booklet —"Inspection and Maintenance of Fire Extinguishers." It tells how to check whether you have the proper types and quantities of extinguishers; how to mark them for quick identification; how often the various types should be inspected; what parts to examine on each unit. It suggests simple forms for keeping records. This booklet is on the press now. Write for your free copy today.

WALTER KIDDE & COMPANY, INC., 231 MAIN STREET, BELLEVILLE, N. J.

TONNAGE AVAILABLE!

IRON POWDER

STEEL POWDER

A Complete Plant Produces Iron Powder With Characteristics Particularly Suited To

POWDER METALLURGY APPLICATIONS

▲ High or Low Apparent Density
▲ High Compactibility
▲ High Sintered Strength
▲ High Rate of Flow
▲ High Purity

POWDER METALS & ALLOYS, INC.
52 Vanderbilt Avenue, New York, N.Y.
PLANT: BARBERTON, OHIO

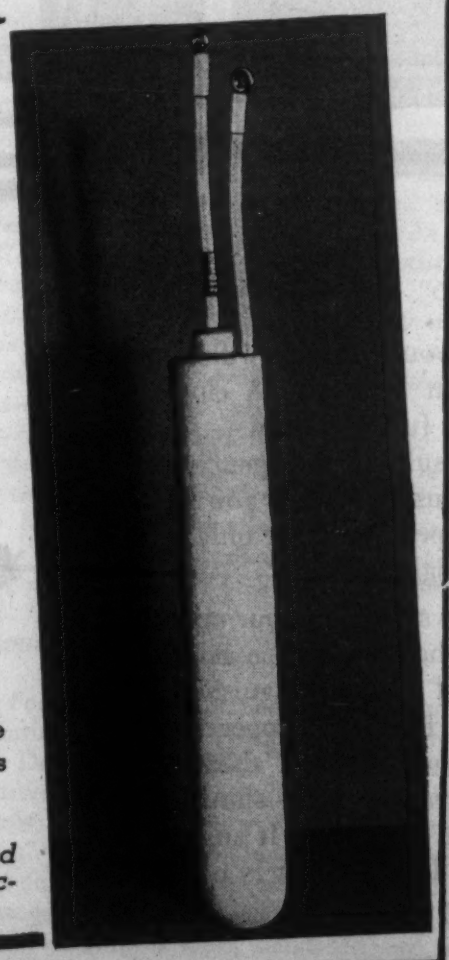
VITREOSIL
IMMERSION HEATERS

Vitreosil Electric Immersion Heaters are of particular value in many instances where liquids of an acid reaction must be heated. For such applications, the Vitreosil envelope of the heating unit combines the advantages of being acid-proof, a good electrical insulator, and resistant to severe thermal shock.

Vitreosil (99.8% SiO_2) is unaffected by all halogens and acids, regardless of temperature or concentration, with the exception of fluorine, hydrofluoric and phosphoric.

Vitreosil Electric Heaters are available in lengths ranging from 10 to 30 inches with k.w. ratings of .25 to 5.0.

Write for full details and quotations on Vitreosil Electric Immersion Heaters.



VITREOUS SILICA — VITREOSIL REG'D TRADE MARK

THE THERMAL SYNDICATE, LTD.
12 EAST 46th STREET, NEW YORK, N. Y.

than 600 standards. They cover specifications for materials, methods of tests, dimensions, definitions of technical terms, procedures, etc. The Association has authorized participation in an Allied Nations Standards Body, comprising British, Canadian and American participants.

A second annual course on "Fundamentals of Foundry Engineering" is announced by Stevens Institute of Technology, in cooperation with the educational committee of the American Foundrymen's Assn. and the U. S. Office of Education. The course will consist of 24 free lectures by 17 leading engineers, foundrymen and metallurgists from war industries over the period, Jan. 6 to March 24.

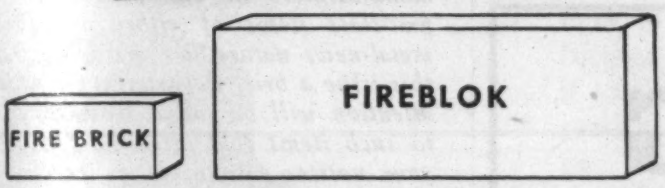
"North America can use the fine Brazilian ores to bolster our own dwindling supplies in return for coal for Brazilian steel mills," stated Dr. A. Allen Bates, chemical and metallurgical manager, Westinghouse Research Laboratories, following a three-months' stay in Brazil. "That country holds in her huge area one-third of the whole world's supply of iron ore. She has also extraordinary opportunities for the development of the electrical power so essential for the conversion of iron ore into the steels of industry. Her illimitable forests are the world's most inexhaustible fuel supply. Recently coal has been discovered in Santa Catarina."

The Pressed Metal Institute has selected O. L. Earl as market development engineer for post-war planning. The Institute is also appointing committees to study materials, methods and markets that affect the future of the pressed metal industry, especially regarding new ferro-alloys, light metals and clad metals. Mr. Earl has been active at the Tank Automotive Center at Detroit.

Formed two years ago, world-wide requests for its services are being asked of the "Clearing House for Consultants," sponsored by the Association of Consulting Chemists & Chemical Engineers, Inc., 50 E. 41st St., New York. It functions in the field of chemistry, engineering and related branches, and establishes a link between science and industry. Operating as a free service, requests have come from as far distant as Africa, Asia, Australia, Central and South America, Europe, Cuba and Jamaica.

The third annual Science Talent Search among 15,000 high school seniors is now under way under the auspices of Westinghouse. A stiff 2-hour science aptitude test has been mailed to high school principals, who will administer the test. The 40 best candidates selected will be invited, expenses paid, to the Science Talent Institute at Washington in March. From these 40 a few will be chosen to receive cash scholarships.

Gaston F. Du Bois, senior vice president, Monsanto Chemical Co., received the Perkin medal at the Jan. 7 dinner of the American section, Society of Chemical Industry, "for his outstanding achievements in applied chemistry."



Large, convenient size and light weight mean faster installation!

TO make possible speedier, more economical installations of insulating refractory linings, Johns-Manville has developed Insulating Fireblok. Available in four grades, Fireblok are suitable for the same range of temperature conditions as the four well-known J-M Insulating Fire Brick. But, one Fireblok covers more surface than five full-size brick. Note these other features:

Easy cutting and fitting—J-M Fireblok can be easily cut with a saw and shaped with a rasp. Most special shapes can be either shop or field cut from standard slabs, reducing the inventory of special shapes.

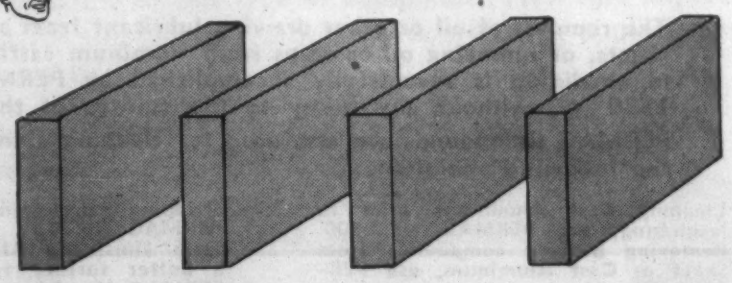
Minimum of Joints—The large size, compared to the standard fire brick unit, materially reduces the number and length of joints, resulting in a thermally more efficient construction.

Economical Bonding—with reduced joint length Fireblok require a minimum of mortar for bonding.

Uses—Fireblok can be used wherever Insulating Fire Brick are recommended. They are particularly suitable for the lining of doors, for suspended arches, and, when tapered, for sprung arches of exceptional stability.

Write for new booklet, IN-103A, on this J-M development. Johns-Manville, 22 East 40th Street, New York 16, N. Y.

"J-M INSULATING FIREBLOK ARE NOW AVAILABLE!"



JM-1620 Fireblok—for exposed temp. to 1600° F. As back-up to 2000° F.

JM-20 Fireblok—for use up to 2000° F. Exposed or back-up

JM-23 Fireblok—for use up to 2300° F. Exposed or back-up

JM-26 Fireblok—for use up to 2600° F. Exposed or back-up

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville
INDUSTRIAL INSULATIONS
FOR EVERY TEMPERATURE . . . FOR EVERY SERVICE

OXYGEN FREE HIGH CONDUCTIVITY COPPER

OFHC
REG. U.S. PAT. OFF.

OFHC *is a universal copper.*

- It is an essential part of electronic devices.
- In that capacity it is accompanying our armed forces everywhere.
- Its unique qualities however do not restrict its use to special applications.

OFHC *is a versatile copper.*

THE AMERICAN METAL COMPANY, LTD.
61 Broadway, New York, N. Y.

FOR QUALITY-PLUS PERMAG CLEANERS LEAD TRADE MARK REG. U.S. PAT. OFF.

PERMAG

Cleaning Compounds

for Aluminum and other Soft Metals

The removal of oil or other drawing lubricant from aluminum sheets, or removing oil or chips from aluminum castings prior to anodizing is successfully accomplished by PERMAG No. 1550 W, without any injury to the surface of the metal.

PERMAG Compounds are also used for cleaning aluminum in the following operations:

- **Cleaning Cast Aluminum, prior to lacquering, use PERMAG No. 500.**
- **Removing buffing compounds from Sheet or Cast Aluminum, use PERMAG No. 44.**
- **Stripping paint from Aluminum, use PERMAG No. 921.**
- **Satin Finish on Aluminum provides a better surface for finishing, use PERMAG No. 24.**

Brass, copper, zinc, white metal and die-castings are cleaned quickly and efficiently with PERMAG Compounds leaving the surface chemically clean and free from tarnish or etching effects.

Our field representatives are trained to advise in the use of PERMAG Compounds. Write us about your needs. No obligation for an interview.

Nationally Represented Warehouses In Principal Cities

MAGNUSON PRODUCTS CORPORATION

In Canada: Canadian PERMAG Products, Ltd., Montreal-Toronto

Manufacturers of Specialized Scientific Cleaning Compounds for Industry

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Meetings and Expositions

TECHNICAL ASSOCIATION PULP & PAPER INDUSTRY, annual meeting. New York, N. Y. February 14-17, 1944.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, annual meeting. New York, N. Y. February 20-24, 1944.

AMERICAN SOCIETY FOR TESTING MATERIALS, spring meeting. Cincinnati, Ohio. February 28-March 3, 1944.

AMERICAN GAS ASSOCIATION, Industrial and Commercial Gas War Conference. Rochester, N. Y. March 30-31, 1944.

AMERICAN CERAMIC SOCIETY, annual meeting. Pittsburgh, Pa. April 2-5, 1944.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Birmingham, Ala. April 3-5, 1944.

ELECTROCHEMICAL SOCIETY, spring convention. Milwaukee, Wis. April 12-15, 1944.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS. Open Hearth and Blast Furnace Conference. Pittsburgh, Pa. April 20-21, 1944.

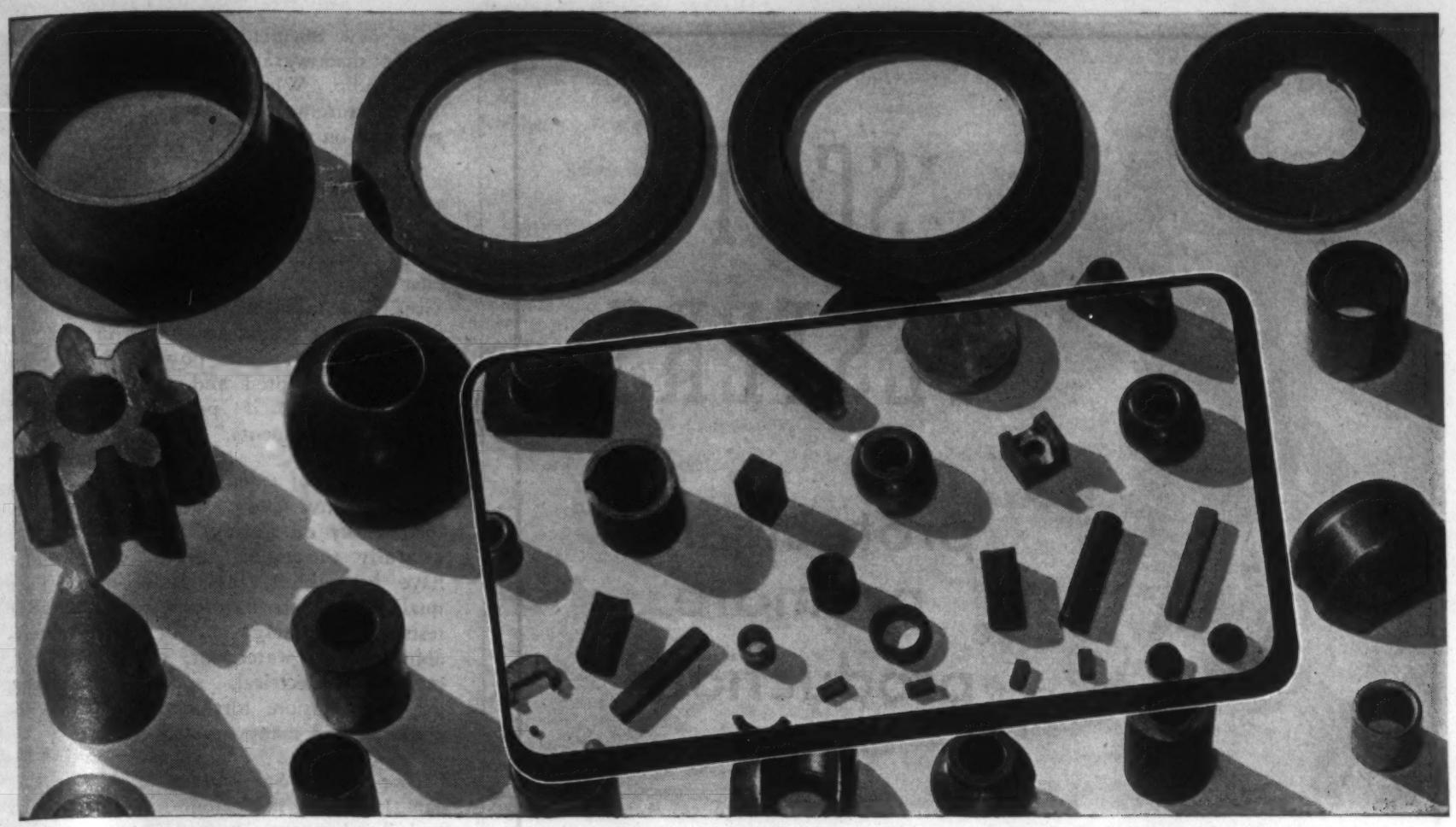
House Organ Digest

Because the so-called "house organs" of manufacturers in our field often contain first-class items of either a technical or metal-news nature, we are inaugurating in this issue a brief department in which your attention will be called from time to time to such items that might otherwise escape your notice. Your editors receive dozens of house organs regularly, and are constantly appalled at the tremendous amount of valuable material they contain that misses general consumption. Other publications are on the list, along with those reviewed below, for future attention.—The Editors.

Otis Sheet, Otis Works, Jones & Laughlin Steel Corp., Dec. 1943.—Many technical details on relining and starting a blast furnace. This must be done thoroughly, as with good fortune the furnace might run 5 to 7 years before another lining. At this time many parts are modernized. Also, a description and micrograph of "rimmed steel," suited for most deep drawing jobs. "As a result of the way it is allowed to 'freeze' in the ingot mold, it has a surface low in carbon and remarkably clean, capable of a high finish upon being cold rolled."

The Bellringer, Bell Aircraft Corp., Jan. 1944.—"Eyes of Industry," illustrated feature article, describes gages of many types which make it possible for Bell's Ordnance Div. at Burlington to follow a nearly perfect system of operational checks. Inspectors discover immediately in a single operation any variance, no matter how insignificant. One of the interesting gadgets

(Continued on page 496)



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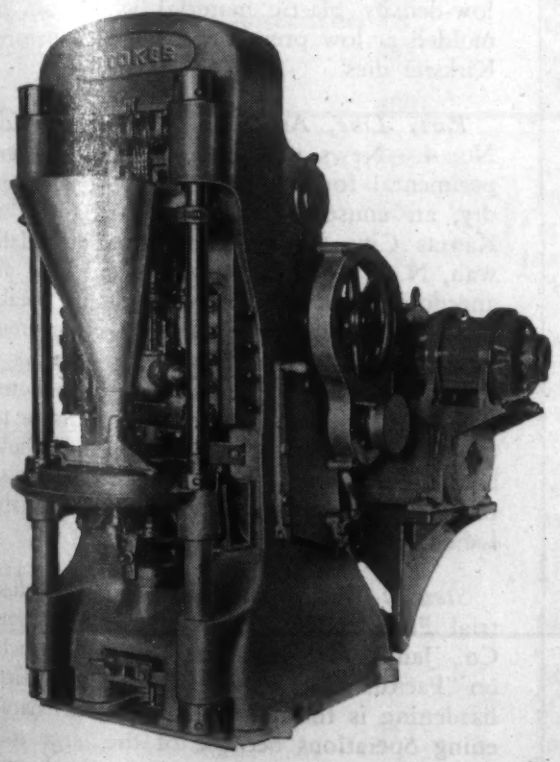

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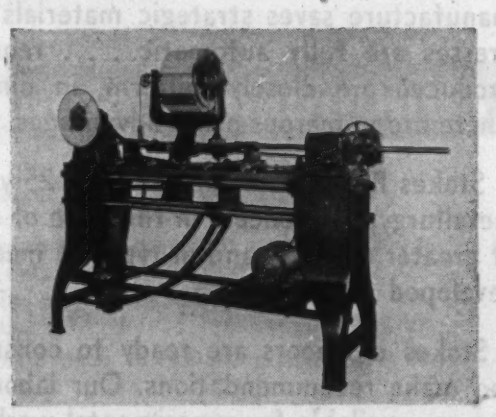

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The Drum, Metals Disintegrating Co., Oct. 1943.—An editorial urges: "Let's debunk a few generalities on powder metal parts production and stop claiming virtues that bring headaches . . . and become vices." Continuing, "Due regard should be given the technical aspects of the particular use to which powder metal parts are to be adapted and the technological elements of their production to meet specific requirements."

Iron Men of Hendy, Joshua Hendy Iron Works, Nov. 1943.—Featured is a pictorial story on testing. "No matter how carefully an engine, turbine or generator have been built, they must prove their quality through a progressive series of tests at every stage and of every conceivable type — water, air, chemical, X-ray, magnetic, electrical, spectroscope, gage, pressure, tension, torsion, mechanical, operational and many others."

The Martin Star, Glenn L. Martin Co., Jan. 1944.—A new laboratory for research and development in new structural materials, especially structural plastic composite materials; for cooperation and consultation with the Engineering Materials group, and for special request testing of plastic materials, etc. is described briefly. Among initial projects will be development of experimental aircraft parts from a new low-density plastic material which can be molded at low pressures, using inexpensive Kirksite dies.

Party Line, American Brake Shoe Co., No. 4.—News item about a full-scale experimental foundry. To house this foundry, an unused factory was dismantled at Kansas City, Kansas and moved to Mahwah, N. J. On the non-technical side, an anecdote about Benjamin Franklin. Breakfasts were always the same, herring from a big barrel in the storeroom. Always a lengthy blessing by Ben's father each morning. Ben finally suggested one blessing to cover all — in the Fall over the whole barrel. (Moral: So with many businessmen, once they get their policies established, they are set for all time.)

Stewart Metal Minutes, Stewart Industrial Furnace Div., Chicago Flexible Shaft Co., Jan. 1944.—Illustrated feature article on "Factors in Broach Hardening." "Broach hardening is the most difficult of all hardening operations because of the large sections of high speed steel involved and the intricate design of many of the tools. These factors result in the setting up of terrific hardening strains, which cause distortion and make straightening most difficult."

The Houghton Line, E. F. Houghton & Co., Dec. 1943.—Among the technical topics are Martempering, quenching speed and blackening propeller blades. The leading illustrated feature story is on the Springfield Armory and Garand rifle, particularly the historical features.

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trends

By Edwin F. Cone

Magnesium

It is reported that the British are using magnesium for warplane gasoline tanks and that this enables them to increase fuel capacity by 12 gallons, to save 9 lbs. in weight and to reduce the "tuliping" of bullet holes which interfere with self-sealing. J. C. Mathes of the Dow Chemical Co. also told a gathering of automotive engineers that the use of cast, forged and extruded magnesium parts has been completely satisfactory but that overloading and impact have caused some premature failures where these magnesium sheets have replaced aluminum. Sheet magnesium was reported to have been found satisfactory for oil tanks, instrument panels, etc. and to permit of weight savings ranging from 11 to 26 per cent when used in surfacing aircraft ailerons, flaps, elevators and tail assemblies.

Post-War Autos

The automobiles of the post-war period will be better but not fantastic, according to Delmar G. Roos, vice-president in charge of engineering for Willy-Overland Motors. Those fantastic dreams of tear-drop, rear-engine cars made of "super" materials with curved glass tops and plastic bodies belong to the next decade, in his judgment. "Plastic bodies and curved glass surfaces, in their present form, are unsatisfactory; the bodies have none of the advantages of steel, while the plastic glass as now developed presents a dangerous handicap to the clear vision needed in driving."

Welding in Building Construction

It is reported that the process of welding is finding wider and wider application in the field of building construction. This is evidenced by the growing number of the country's larger cities which have provisions in their building codes for the use of the process. The larger cities include 29 of over 100,000 population and 41 of a population of 25,000 to 100,000. There are 28 cities of over 25,000 population in which builders may use welding by special permit.

A New Low-Alloy, High Strength Steel

A new low-alloy high strength steel has been patented and introduced by the Alloys Development Co., New York. It is known as "Aldecor" and will be available from a number of producers licensed under the patent. The steel as produced may contain: C, 0.06 to 0.12; Mo, 0.18 to 0.30; Cu, 0.35 to 0.55; Si, 0.45 to 0.65 and P, 0.08 to 0.13%. Minimum yield point in ½-in. sections or less is 50,000 p.s.i. Like Corten and other similar steels it is used in the "as rolled" condition. Thisi s first new steel of this type to appear in 2 or 3 yrs.

Steel Motor Highways

American motorists may be zipping over steel highways soon after the war. "Armoring of highways may be an offshoot of the technique employed at battlefronts in laying down landing mats for the air force. An experimental section of a highway in Darien, Conn., has been laid. The installation, while only 48 ft. long and 22 ft. wide, is expected to provide the answer to the practicability of entire roads of steel grid.

Die Castings

Hundreds of items have been changed from screw machine products, forgings, sand castings and other methods of fabrication to the die casting process as a conservation measure. The expanded use of die castings with their characteristic high-speed production and low scrap loss has represented huge savings in critical materials, manpower and machine hours — according to the chairman of the conservation division of the WPB.

Airplane Propellers

The size of modern airplane propellers is on the increase. What is claimed to be the latest 4-bladed propeller is announced by the Curtiss-Wright Corp. It is of the hollow steel blade electric controllable type, measuring 16 ft. 8 in. in diameter and weighing nearly 800 lbs. It is on exhibit at the New York Museum of Science.

Shipments of Aluminum Castings

In line with the new policy of the WPB of releasing for the use of industry data which will assist business in forward planning, shipments of aluminum castings reached a new record high of 40,844,000 lb. in September 1943, an increase of more than 100% above the January 1942 level. The biggest increase has been in heat-treated sand castings for cylinder heads and other large parts. The September total was made up of 27,213,000 lb. of sand castings, 7,959,000 lb. of permanent mold castings, and 5,672,000 lb. of die castings.

More Steel Castings

Production of steel castings has been on the increase in the last three years and reached a peak in 1943, says the WPB. In 1943 the total was 2,742,604 tons — this compares with 2,239,693 tons in 1942 and with 1,577,736 tons in 1941.

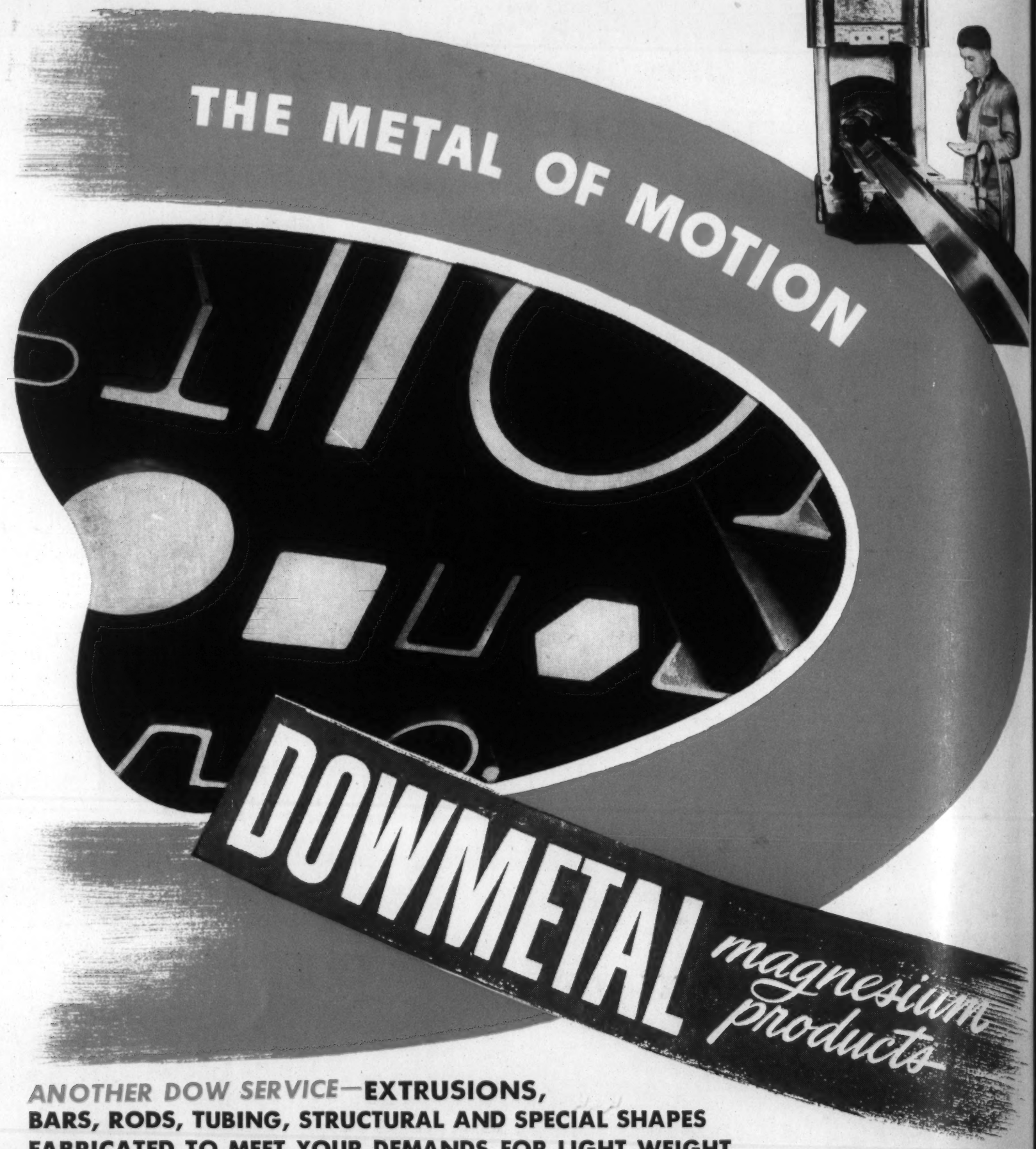
MAR 30 1944

METALS and ALLOYS

The Engineering Magazine of the Metal Industries

MARCH 1944

Metal Production · Metal Working · Materials and Design



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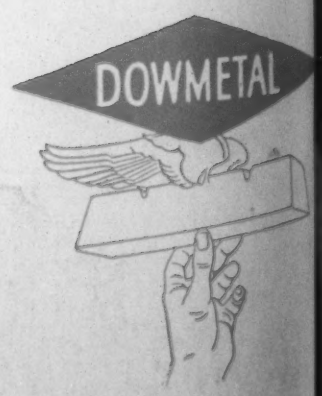

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